

U.S. Army Environmental Center Report No. SFIM-AEC-ET-CR-95077 FINAL REPORT Volume 2 of 4

Project Summary Report for Pilot-Scale Demonstration of Red Water Treatment by Wet Air Oxidation and Circulating Bed Combustion

October 1995 Contract No. DACA31-91-D-0074 Task Order No. 0005

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FINAL

PROJECT SUMMARY REPORT

FOR

PILOT SCALE DEMONSTRATION OF RED WATER TREATMENT BY WET AIR OXIDATION AND CIRCULATING BED COMBUSTION

VOLUME 2 OF 4

USAEC Contract No. DACA 31-91-D-0074 Task Order No. 5

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IT Corporation Cincinnati, Ohio

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As part of the U.S. Army's ongoing program related to the research and development of red water treatment technologies, the U.S. Army Environmental Center (USAEC) contracted IT Corporation to prepare conceptual designs and plans for pilot-scale demonstrations of two treatment technologies: wet air oxidation (WAO) and circulating bed combustion (CBC). The project objectives also included development of a Test Plan and Health and Safety Plan for these demonstrations, and preparation of a Project Report. This Project Report is intended to summarize the conceptual designs, Test Plan, and Health and Safety Plan and to serve as a guide for activities when the next phase of this program (i.e., conducting the demonstrations) is implemented.

Red water is not currently generated by the U.S. Army or any other part of the U.S. Department of Defense nor has it been generated in the recent past. An accurate and complete database does not exist in regard to the chemical and physical nature of red water. Due to this lack of waste characterization data, it was not possible to complete an accurate analysis of the associated testing and treatment requirements. Additionally, the source of red water for testing and the location where the tests will be conducted (i.e., the host facility) have not been identified. Therefore, waste- and site-specific concerns and requirements cannot be accurately or completely addressed at this time. As a result, this phase of the investigation included completion of plans and conceptual designs. Completion of system designs and finalization of test and safety plans must be completed in the future prior to initiation of the demonstration program.

This Project Report outlines the current project status and identifies the steps which must be completed prior to conducting the demonstrations. These include: selecting a host facility, obtaining red water for the demonstrations, characterizing the red water, preparing final process and equipment designs, finalizing Health and Safety and Test Plans, and acquiring the test equipment. Because of the unique and largely undocumented nature of red water, once a source has been identified, a critical initial objective will be characterization of the physical and chemical nature of the waste and a review of the associated treatment requirements.

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WET AIR OXIDATION CONCEPTUAL DESIGN REPORT (Prepared by Kenox Corporation)

WET AIR OXIDATION PILOT **PLANT**

FOR

RED WATER

CONCEPTUAL DESIGN REPORT

Prepared For:

IT CORPORATION Cincinnati, Ohio

Kenox Project No. Purchase Order No. 483392

UJ41014

December 1994

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SECTION 1.0. GENERAL DESCRIPTION

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1.0. GENERAL DESCRIPTION

1.1. INTRODUCTION

Red water is the waste water generated from the purification stage of the manufacturing process of 2,4,6-trinitrotoluene (TNT). During the purification stage, a sellite solution is added to the crude TNT to remove unsymmetrical isomers. The red water generated contains dinitrotoluene (DNT) sulfonated compounds and products of incomplete nitration of toluene to TNT (i.e. priority pollutants 2,4-DNT and 2,6-DNT).

Red water is currently classified by the EPA as an RCRA-regulated reactive hazardous waste (KO47). The feasibility of using Wet Air Oxidation (WAO) for the treatment of TNT red water was confirmed by the study which was performed by the Department of Civil Engineering at the University of Maryland, under contract with the U.S. Army Construction Engineering Research Laboratory. As a result, the U.S. Army Environmental Center (USAEC) has decided to investigate a piloting program to treat TNT red water in a Wet Air Oxidation system.

This document is prepared as part of the task entitled "Red Water Treatment Technology Test Plan and Site Preparation" for the USAEC. The objectives of this task are to prepare test and safety plans, determine the best conceptual designs, and prepare layouts for pilot scale Circulating Bed Combustors (CBCs) and WAO treatment systems. Due to the uncertainty of the pilot plant demonstration location, the units are designed to be transportable.

This design package presents the conceptual design, layout and cost estimate of a mobile Kenox Wet Air Oxidation pilot plant. Further process engineering and detailed design engineering is necessary prior to construction of the Kenox pilot plant.

The Kenox WAO system presented here is a transportable pilot plant consisting of a feed preparation and preheat section, reaction section and separation and pressure let down section. The red water is diluted and preheated in the feed preparation section and then mixed with air prior to entering the reaction section. The reactor system operates at 484 deg F and 1000 psia. Spent air and oxidized waste leaving the reactor system are cooled and fed into a two stage pressure let down and separation system prior to being discharged from the WAO system.

This design package contains the following major sections:

- 1.0 General Description Presents a brief introduction to the project and contents, the WAO design basis and a WAO block diagram.
- 2.0 Process Description Presents a process overview of the Kenox WAO system and a description of each key system section.

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- 3.0 PFD and P&IDs Package Presents the Process Flow Diagram (PFD) and the Piping and Instrumentation Diagrams (P & IDs) for the WAO system.
- 4.0 Equipment List Presents a table of the key equipment components.
- 5.0 Equipment Specifications Presents the process specification sheets for each key WAO component.
- 6.0 Utility Consumption Presents the utility consumptions of the WAO system.
- 7.0 General Arrangement Drawings Presents the general arrangement plans for the WAO system.
- 8.0 Electrical One-Line Drawing Presents the electrical one-line drawing for the WAO system.
- 9.0 Mass & Energy Balance Outputs Presents the basis and results of mass and energy balances conducted for normal operations.
- 10.0 Pilot Plant Cost Estimate Presents the cost estimates for purchase and lease of Kenox WAO equipment.
- 11.0 Treatability Study Presents the autoclave procedures and results.
- 12.0 Operations & Safety Considerations Presents the health and safety considerations of the WAO operations.
- 13.0 Sampling Plan Presents the general process and emissions sampling procedures.
- 14.0 Operations Manual Presents a draft Kenox WAO operations manual.

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1.2. DESIGN BASIS

In preparing this conceptual design, Kenox has relied to a significant extent on the experimental data, observations and results presented in the Phull (1992) and Hao (1993) reports and Kenox' preliminary treatability study on the TNT red water. Additional assumptions and considerations were also made in the absence of data. These assumptions and the literature review results require confirmation through an extended treatability study before the design of the system is to be finalized. The initial conceptual design basis and considerations are discussed below.

1.2.1. Red Water Characteristics

The manufacturing process of 2,4,6-trinitrotoluene (TNT) consists of two stages: (i) nitration of toluene to crude TNT and (ii) sellite purification to remove the unsymmetrical TNT isomers and other impurities. During the purification stage, the sodium sulfite (sellite) that is added to crude TNT, reacts selectively with the unsymmetrical TNT isomers to produce dinitrotoluene (DNT) sulfonated compounds. The waste water which is generated during this stage (also known as red water) contains the dinitrotoluene sulfonated compounds, products of incomplete nitration of toluene to TNT from the first stage and other complex byproducts formed during the nitration and purification stages.

Based on Radford Army Ammunitions Plant data on red water characteristics (forwarded by IT Corporation to Kenox, see Tables 1.1 and 1.2), red water in general has a COD range of 65,000 mg/l to 120,000 mg/l, a pH of 7.0 to 9.7 and contains 15 to 30 percent solids. Inorganic salts make up 45 wt% of the solids and nitrobodies make up the remaining 55 wt%.

This conceptual design assumes that dinitrotoluene sulfonated (DNTS) compounds constitute the major COD contributor in red water. Due to limited physical data available on DNTS, the mass and energy balance assumed the following sequence of reaction pathways: (1) removal of the sulfonic group from DNTS to form dinitrotoluene and sulfuric acid; and (2) oxidation of dinitrotoluene with air to produce carbon dioxide, water and nitrogen.

1.2.2. Dilution of Feed

The selection of the design pressure of the reactor system will have to take into account the overpressurization of the system in the event of an uncontrollable reaction. Kenox' preliminary evaluation indicated that the optimum system design pressure can be achieved at a feed concentration of 6 % COD.

1.2.3. Design Conversion Levels and Feed Rates

The Kenox pilot plant is designed to treat 1.5 USGPM of raw red water at a COD level of 120,000 mg/l. The incoming red water will be diluted to a COD level of 60,000 mg/l with a treated effluent recycle stream due to safety concerns and excessive evaporation in the Kenox reactors with the high incoming COD level. The design throughput after dilution of the feed stream is 3.0 USGPM. Experimental data reported in Phull's dissertation (1992), predict a COD conversion in the 85% range at WAO reaction conditions of 485 deg F.

1.2.4. pH Adjustment

Initial pH of the waste feed stream can have a significant impact on the performance of the oxidation reaction. In this Kenox design, a feed pH of 5 is required.

1.2.5. Definitions of Kenox Inside Battery Limits

The Kenox inside battery limits are defined as follows:

- Inlet of the Kenox unit: Feed to the suction of the waste feed pump, P-101.
- Outlet of the Kenox unit: Effluent from the discharge of the final effluent pump, P-105.
- Refer to the attached PFD in Section 3.0 for details on the definitions of Kenox inside battery limits.

1.2.6. Design Inlet Battery Limit Conditions

Raw Feed Flow, USGPM	1.5
pH	7.0 - 9.7
COD, mg/l (min/max)	65,000/120,000
Temperature, deg F	60
Compositions	see Tables 1.1 & 1.2

1.2.7. Design Outlet Battery Limit Conditions

pH	2.0 - 4.0
Temperature, deg F	107
Pressure, psia	50
COD, conversion	85%

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1.2.8. Material of Construction

As reported in Phull's dissertation, the corrosivity of red water is aggravated under process conditions of high temperature, high pressures and low pH of oxidized solutions. Sulfonated nitroaromatics are expected to be more corrosive when subjected to WAO due to the formation of inorganic salts. On the basis of the corrosion testing performed by Phull, titanium is selected as the material of construction for Kenox reactors and associated equipment and piping when the process temperature exceeds 100 °F. For process effluent temperatures less than 100 °F, equipment and piping will be constructed from 316 stainless steel. pH adjustment on the rundown effluent from the Kenox unit, if required is not included in the design scope.

1.2.9. Plot Area

Due to the uncertainty of the pilot plant demonstration location, the unit is designed to be transportable and to be operable indoors or outdoors. The required minimum plot space for this Kenox unit is approximately 16' x 48'.

1.2.10. Service Factor

It is anticipated that the service factor for the Kenox system will be in the order of 90 %. Rotating equipment spare parts inventories are at the client's choice and judgment between the penalty for short term shutdown versus the cost of the spare equipment. However, Kenox recommends that spare parts for critical and long term delivery items be stored. A list of spare parts will be provided upon the completion of detailed engineering.

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Table 1.1 Red Water Characteristics

Chemical Oxygen Demand, mg/L Total Solids, % Specific Gravity Nominal Solids Heat Value Suspended Solids, mg/L pH Soluble Chloride, mg/L Total Kjeldahl Nitrogen, mg/L Nitrate Nitrogen, mg/L Nitrite Nitrogen, mg/L	65,000 - 120,000 15 - 30 1.1 3,200 BTU/lb 32 7.0 - 9.7 70 11,129 1,739 6,788 150
Ammonia Nitrogen, mg/L Metals, mg/L	150
Calcium	39 - 346
Iron	4.9 - 307
Magnesium	25 - 90
Potassium	42
Aluminum	2.1 - 10
Chromium	0.14 - 4.9
Barium	0.22 - 3.0
Copper	2.3
Cadmium	0.7
Silver	0.4
Zinc	6.4

Reference: Radford Army Ammunitions Plant, 1988, "Review of Canadian Industries Limited's Boloeil Facility as a Candidate for a SRP Pilot Test."

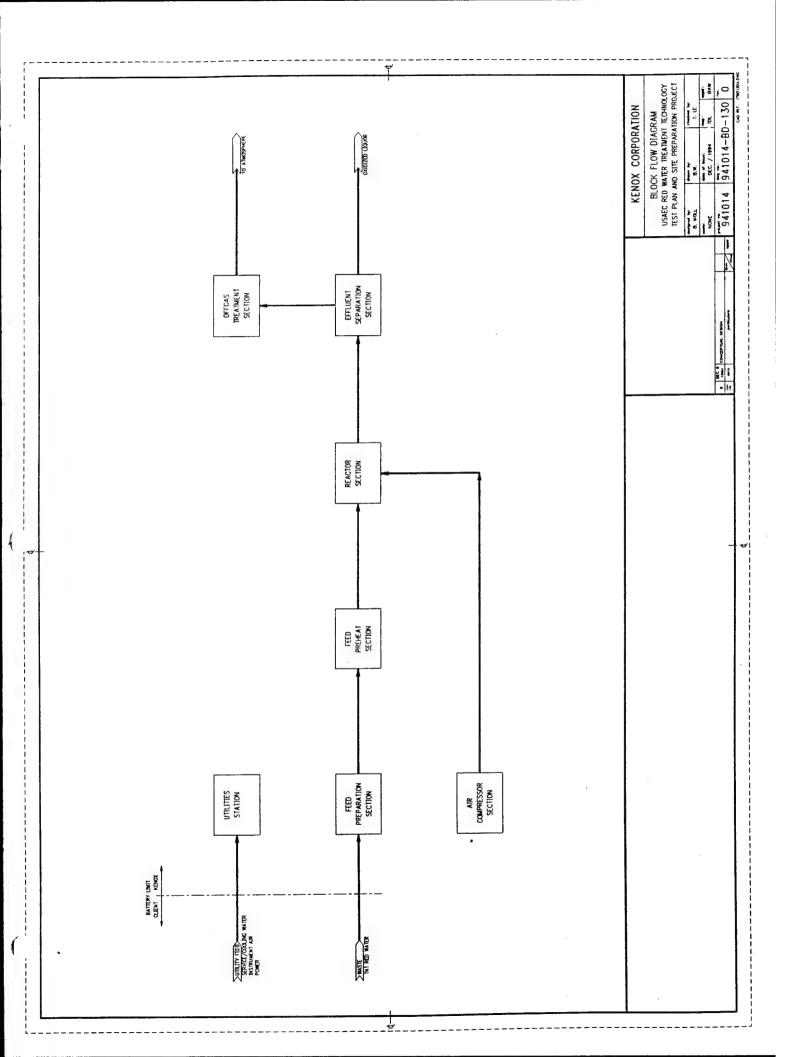
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Table 1.2 Composition of Red Water Solids

Inorganic Salts, wt%	
Na ₂ SO ₃ -Na ₂ SO ₄	32.3
NaNO ₂ (sodium nitrite)	11.2
NaNO ₃ (sodium nitrate)	1.5
NAHS-Na ₂ S (sodium sulfide)	may be present
Sodium bicarbonate/carbonate	may be present
Subtotal Inorganic Salts, wt%	45
Subtotal morganic survey	
Nitrobodies, wt%	
Sodium sulfonate of 2,4,5 TNT	22.7
alpha - TNT - Sellite complex	16.2
Sodium sulfonate of 2,3,4 TNT	9.6
Sodium sulfonate of 2,3,5 TNT	2
Sodium sulfonate of 2,3,6 TNT	trace
2,4,6-TNBA (trinitrobenzoic	1.0
acid) Na salt	
White compound sodium salt *	1.0
TNBAL - bisulfite addition	1.0
compound	
(trinitrobenzaldehyde)	
TNBOH (trinitrobenzyl	1.0
alcohol)	
Sodium nitroformate	0.5
3,4 - DNBA (dinitrobenzoic	trace
acid) Na salt	
2,3 - DNBA (dinitrobenzoic	trace
acid) Na salt	
TNB (trinitrobenzene) - Sellite	trace
complex	
Dissolved 2,4-DNT	trace
(dinitrotoluene)	
Dissolved alpha - TNT	trace
(trinitrotoluene)	
Subtotal Nitrobodies, wt%	<u>.</u> 55

^{* &}quot;White compound" is believed to be 2,2-dicarboxy-3,3"5,5"-tetranitroazoxybenzene

Reference: Radford Army Ammunitions Plant, 1988, "Review of Canadian Industries Limited's Boloeil Facility as a Candidate for a SRP Pilot Test".



SECTION 2.0.
PROCESS DESCRIPTION

Project No.: UJ41014

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Project No.: UJ41014 Revision : 1 Date :12/23/94

2.0. PROCESS DESCRIPTION

The following process description refers to equipment shown on the PFD and P&IDs in Section 3.

2.1. FEED PREPARATION & PREHEAT

To prevent excessive evaporation in the Kenox reaction section, the maximum COD concentration for TNT red water to be processed in this WAO system is 6%. For TNT red water containing COD level above 6%, feed dilution is required before being introduced to the Kenox reactor. TNT red water from storage outside Kenox' battery limits is pumped at a rate of 1.5 USGPM by waste feed pump, P-101, to the feed drum, D-104. At the inlet of this drum, the waste is mixed with a treated Kenox effluent recycle stream which is delivered by the final effluent pump P-105, or service water via dilution feed pump P-102 to maintain the maximum COD in the feed at 6%. This blending is performed by the flow ratio controller, FFRC-401.

The diluted feed is pumped from the feed drum by high pressure feed pump, P-103 to the inlet tubeside of feed/effluent exchanger, E-101 where it is preheated by the reactor system's effluents to the required inlet temperature to the Kenox reactor section. During start up, the electric heater E-102 will be used to heat the feed up to the desired reaction temperature.

2.2. REACTION & SEPARATION SECTIONS

The Kenox reaction section comprises of reactors connected in series. Compressed air is injected into the reactors to supply the required oxygen for the reaction. Reactor effluent is cooled to 104 deg F via the feed/effluent exchanger E-101 and the water cooler, E-103. Spent air and oxidized waste water leave the cooler and proceed to a two stage pressure let down and separation system, D-101 and D-102.

The off-gas, which at this point is mainly carbon dioxide, nitrogen and water vapor is vented to the atmosphere. The oxidized waste water is sent to the effluent drum, D-105. From the outlet of D-105, part of the oxidized waste water is recycled back via the effluent recycle pump, P-105 to the discharge of the feed waste pump, P-101. The other portion is pumped to the client's storage outside Kenox' battery limits.

2.3. COMPRESSED AIR

Air is supplied to the Kenox reactors by the reciprocating compressor, C-101. Compressed air leaving the compressor at 1050 psia flows to the air accumulator D-103. The total air flow to the Kenox reactors is controlled by an oxygen analyzer which measures the O₂ content of the offgas leaving the system.

SECTION 3.0.

PFD AND P&IDs PACKAGE

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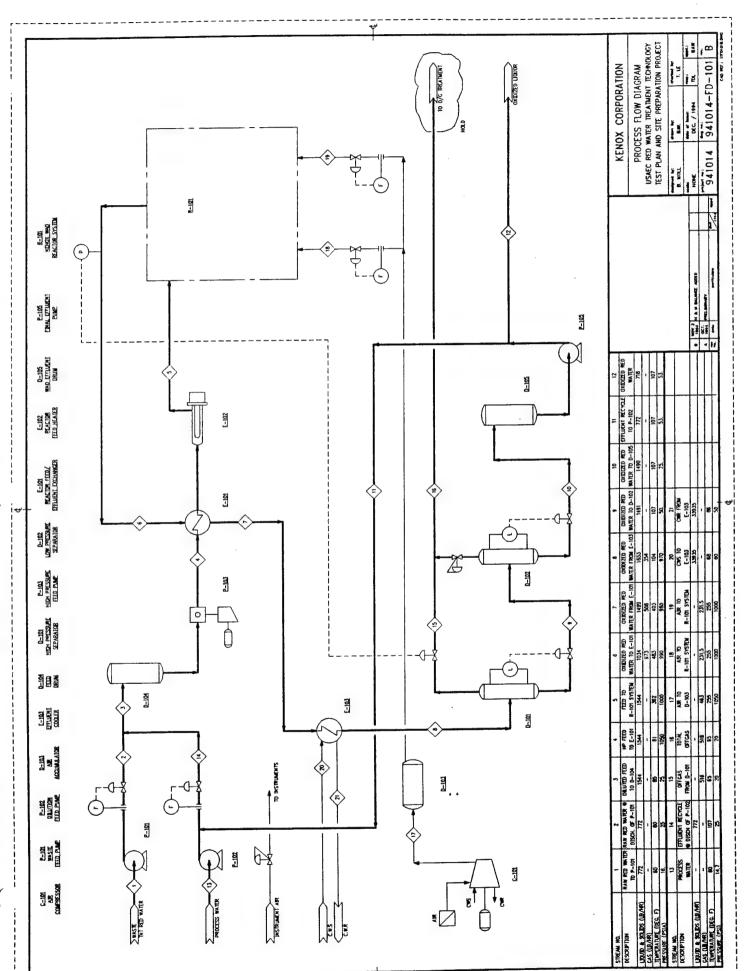
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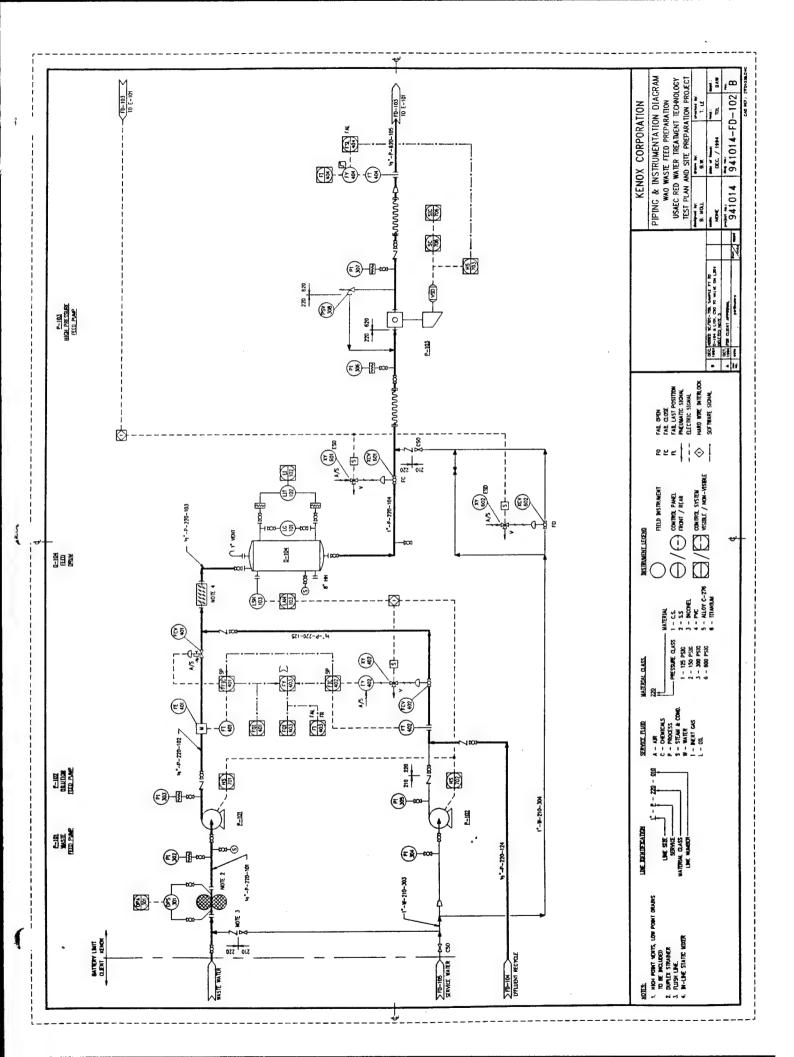
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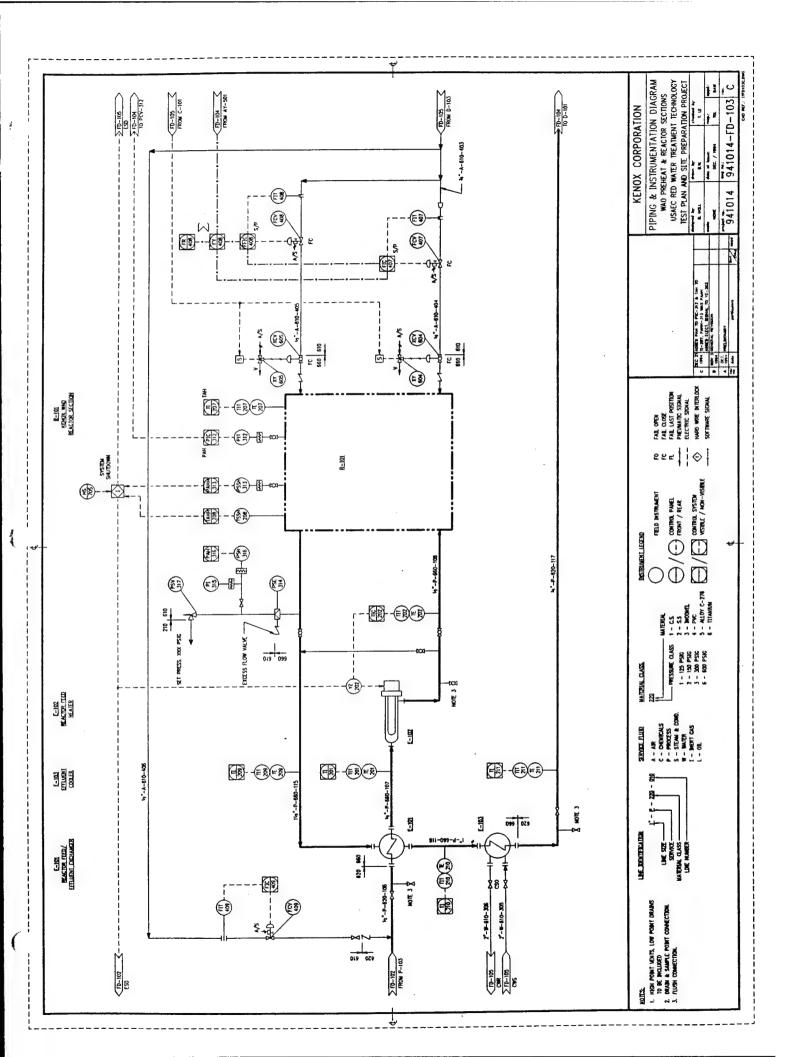
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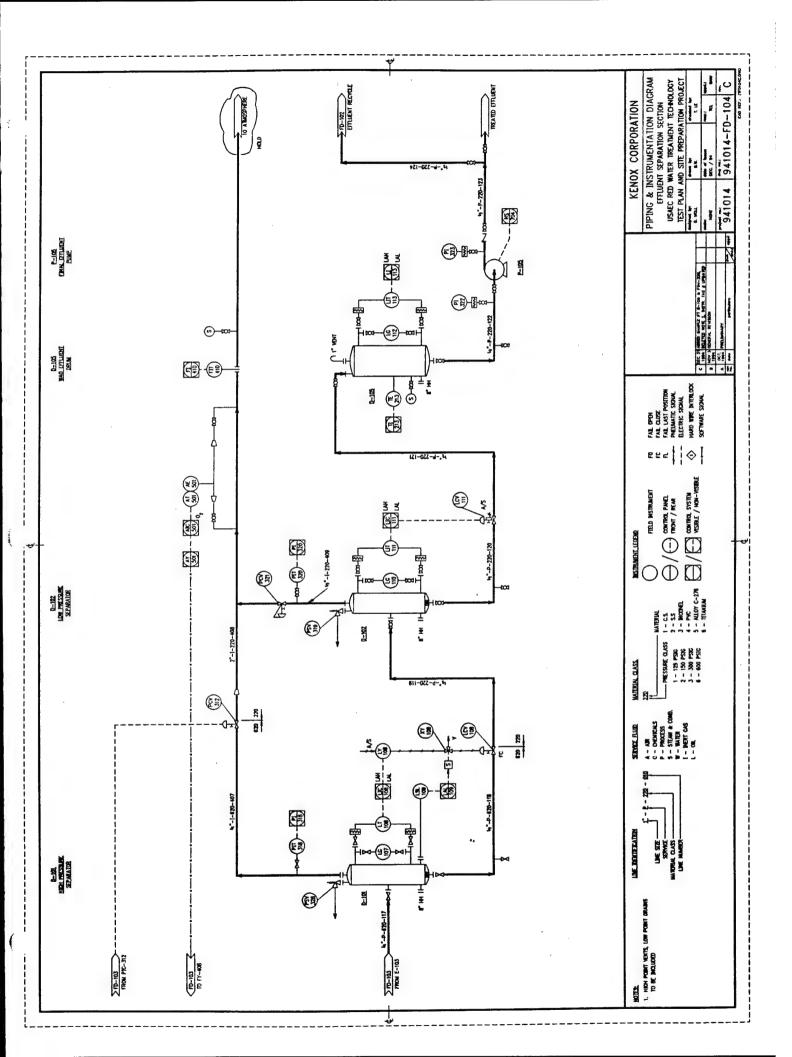
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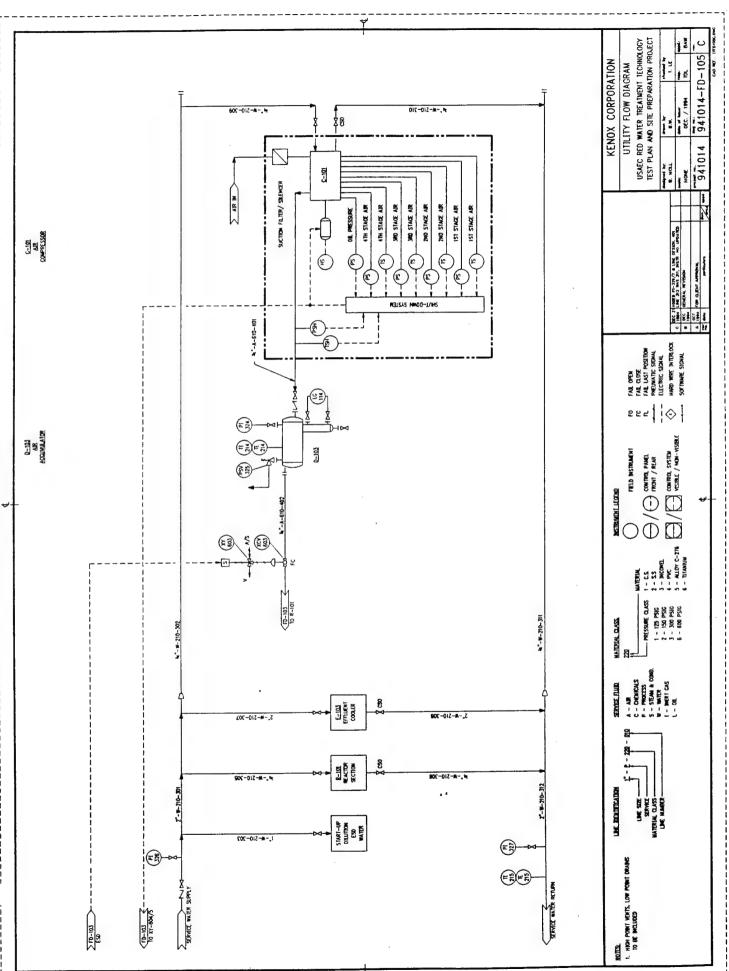
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941014-FD-101	ITFD101B.DWG	PROCESS FLOW DIAGRAM	30/10/94	2/11/94							
941014-FD-102	ITFD102B.DWG	P&ID - WAO WASTE FEED PREPARATION	30/10/94	9/12/94		-					
941014-FD-103	ITFD103C.DWG	P&ID - WAO PREHEAT AND REACTOR SECTIONS	30/10/94	3/11/94	21/12/94						
941014-FD-104	ITFD104C.DWG	P&ID - EFFLUENT SEPARATION SECTION	30/10/94	3/11/94	21/12/94						
941014-FD-105	ITFD105C.DWG	UTILITY FLOW DIAGRAM	30/10/94	9/12/94	21/12/94						
941014-EL-110	ITEL110A.DWG	EQUIPMENT LAYOUT (ELEVATION 8'-6")	ı	4		21/12/94					
941014-EL-111	ITEL111A.DWG	EQUIPMENT LAYOUT (ELEVATION 11'-6")	•	•	•	21/12/94					
941014-BD-130	ITBD130A.DWG	BLOCK FLOW DIAGRAM	•	•	1	9/12/94					
941014-SP-140	ITSP140A.DWG	BLOCK FLOW DIAGRAM - SAMPLING LOCATIONS	1	•	•	21/12/94					
ELECTRICAL											
941014-E-120	ITE120A.DWG	SINGLE LINE DIAGRAM	1	•	,	9/12/94					
·											











Sales .

SECTION 4.0.

EQUIPMENT LIST

Project No.: UJ41014

Revision: I

Date: 12/22/94

1

KENOX CORPORATION

CLIENT: IT CORPORATION

PROJECT: USAEC RED WATER TREATMENT TECHNOLOGY TEST PLAN AND SITE PREPARATION PROJECT

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	DESIGN	
DESCRIPTION	CONCEPTUAL DESIGN	
APPR.	BAW	
CHKD.	BW	
DATE	NOV 30/94	
ISSUE	0	

TAG NO.	EQUIPMENT NAME	TINO	CAPACITY	DISCHARGE	MOTOR	TYPE	MATERIAL	C.W.	POWER	REMARKS
		WEIGHT (LB.)	(SCFM)	PRES.(PSIA)	HP RPM			(USGPM)	(KW)	
C-101	AIR COMPRESSOR	7000	112	1050	100	4 STG. RECIP.	C.S.	12	90	
		WT. EMPTY	SIZE	DESIGN	DESIGN	INSULATION	MATERIAL			
		(LB.)	1.D. X T/T	PRES.(PSIA)	TEMP. (°F)	TYPE THK (IN.)				
D-101	HIGH PRESSURE SEPARATOR	550	13" 4'-0"	1070	155	dd	316 S.S.		•	
D-102	LOW PRESSURE SEPARATOR	340	13" 4'-0"	75	160	ф	316 S.S.	•	•	
D-103	AIR ACCUMULATOR	900	14" 4'-0"	1160	310	НС	c.s.		,	
D-104	FEED DRUM	1250	40. 80.	30	135	z	316 S.S.	,		
D-105	WAO EFFLUENT DRUM	1250	40. 60.	30	160	z	316 S.S.	-		
		SURFACE	DUTY	DESIGN PRES.	DESIGN TEMP.	INSULATION	MATERIAL			
		AREA(SQ. FT.)	(K BTU/HR)	SHELL TUBES	SHELL TUBES	TYPE THK (IN.)	SHELL TUBES			
E-101	REACTOR FEED EFFLUENT EXCH.	24	431	1090 1180	535 415	НС	п п		-	DOUBLE PIPE
E-102	REACTOR FEED HEATER	•	324	N/A 1160	N/A 530	НС	N/A TI		95	ELECTRIC HEATER
E-103	EFFLUENT COOLER	36	589	720 1080	140 455	ЬР	CS TI	88	•	DOUBLE PIPE
		UNIT	NORMAL FLOW	PRES. (PSIA)	MOTOR	TYPE	MATERIAL			
	••	WEIGHT	RATE (USGPM)	DISCH. DIFF.	HP RPM		WETTED PARTS			
P-101	WASTE FEED PUMP	75	1.5	46 30	0.75 3450	CENTRIFUGAL	316 S.S.	•	0.5	
P-102	DILUTION FEED PUMP	75	1.5	46 30	0.75 3450	CENTRIFUGAL	316 S.S.	•	0.5	
P-103	HIGH PRESSURE FEED PUMP	06	3	1050 1030	3 600	POSITIVE DISPL.	316 S.S.	•	1.6	DIAPHRAGM
P-105	FINAL EFFLUENT PUMP	75	3	28 82	1 3450	CENTRIFUGAL	316 S.S.	•	0.75	
		WT. EMPTY	SIZE	DESIGN	DESIGN	INSULATION	MATERIAL			
		(LB.)	I.D. X T/T	PRES.(PSIG)	TEMP. (°F)	TYPE THK (IN.)				
R-101	REACTOR SECTION	6200		1100	535	НС	TITANIUM	15	7	

LEGEND:

INSULATION - HC - HEAT CONSERVATION

PP - PERSONNEL PROTECTION

AS - ANTI-SWEAT

N - BARE

SECTION 5.0. EQUIPMENT SPECIFICATIONS

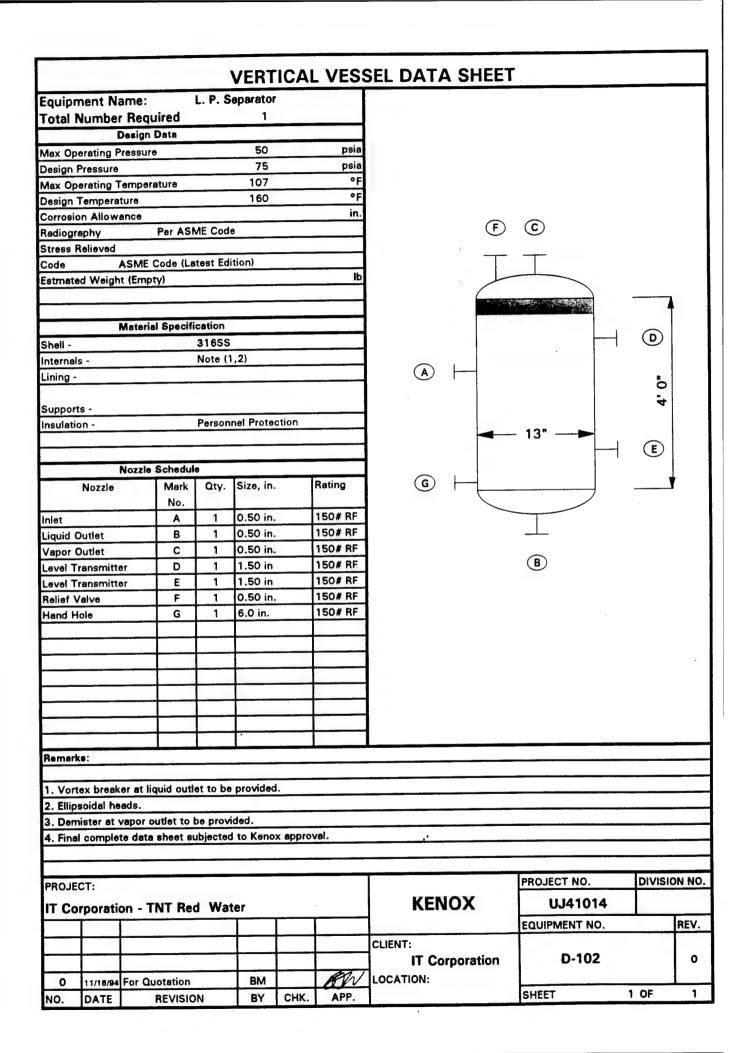
Project No.: UJ41014

Revision: 1

Date: 12/22/94

			CC	MPF	RESS	OR DATA SHEET	Γ		
	ment Na		Compres	sor				-	
Total	Number i	Required	One						
	DESIG	CONDITIONS				C-101			
Gas H	landled					Air			
Std. C	Capacity		SCFM			112			
Weigh	nt Flow		lb/hr			510			
Critica	al Pressur	e	psia			547			
Critica	al Temper	ature	deg F			-221			
	ve Humid								
Molec	ular Weig	ht			<u> </u>	28.8			
	Inlet								
Pressi	ure		psia			14.7			
Temp	erature		deg F			Ambient			
Cp/Cv	,					1.4			
	ressibility					1			
Inlet \	/olume		ACFM			113			
	Outlet								
Press	ure		psia		!	1050			
_	erature		deg F		<u> </u>				
Cp/Cv									
	ressibility								
Discha	arge Volu		CFM		<u> </u>				
	Miscell	aneous							
Adiab	atic		kW		ļ				
BHP			kW		<u> </u>				
Speed			rpm		!				
					-				
	C	Corportions		(1)		Motor			
C		ssor Connections	in., Ra			Motor hp			-
	n Size		in., Ra				60 Phase 3	Hertz	60
Discharge Size in., Rating Cooling Water						Electrical Classificat			
Inlet Temp. 68 deg F					dea F	Materials			
Differential Temperature 18 deg					Casing			-	
Max. Allowable Pressure Drop ps						Piston			
IVIAX. Allowable Pressure brop psi				Shaft					
Remai	rks:								
	1. Con	pressor vendor to co	nfirm and	supply a	all applic	able information to fully com	plete data sheet.		
		ling is not required fo							
		pressor vendor to su							
		(i) Suction air filters		ers					
		(ii) Pressure relief val	ves.						
		(iii) Local temperature		sure ga	uges for	all stages			
		(iv) Shutdown protect							
		(v) Compressor contr	ol system	to be m	ounted	n appropriate enclosure.			
		(vi) Motor starter wit	h enclosu	re.					
						**			
PROJ	ECT:						PROJECT NO.	DIVISIO	ON NO.
IT Corporation - TNT Redwater				KENOX	UJ41014				
					T		EQUIPMENT NO.		REV.
						CLIENT:			
<u> </u>	1		1	—		IT Corporation	C-101		0
0	11/22/94	For Quotation	ВМ	-	BW	LOCATION:			
NO.	DATE	REVISION	BY	снк.			SHEET	1 OF	1

VERTICAL VESSEL DATA SHEET H. P. Separator Equipment Name: **Total Number Required** Design Data 970 psia Max Operating Pressure 1070 psia Design Pressure ۰F 104 Max Operating Temperature 155 ٥F Design Temperature in. Corrosion Allowance Radiography Per ASME Code Stress Relieved ASME Code (Latest Edition) Code lb Estmated Weight (Empty) **Material Specification** D 31655 Shell -Note (1) internals -(A)Lining -Supports -Personnel Protection Insulation -13" (E) Nozzle Schedule Rating Nozzle Mark Qty. Size, in. No. 0.75 in. 600# RF Inlet Α 600# RF В 0.50 in. Liquid Outlet 1 0.75 in. 600# RF C Vapor Outlet Level Transmitter D 1.50 in 600# RF 1.50 in 600# RF Ε Level Transmitter F 1.0 in. 600# RF Level Switch 600# RF G 6.0 in. Hand Hole 1.0 in. 600# RF Н Relief Valve Remarks: 1. Vortex breaker at liquid outlet to be provided. 2. Ellipsoidal heads. 3. Final complete data sheet subjected to Kenox approval. PROJECT: PROJECT NO. DIVISION NO. KENOX UJ41014 IT Corporation - TNT Red Water EQUIPMENT NO. REV. CLIENT: D-101 **IT Corporation** 1 BM 12/21/94 NOZZLE 'H' ADDED BM LOCATION: 11/16/94 For Quotation 0 SHEET 1 OF APP. DATE REVISION CHK. NO. BY



HORIZONTAL VESSEL DATA SHEET Air Accumulator Equipment Name: **Total Number Required** Design Data 1050 Max Operating Pressure psia 1160 psia Design Pressure ۰F 255 (1) Max Operating Temperature ۰F 310 (1) Design Temperature 4"-0" in. Corrosion Allowance Per ASME Code Radiography Stress Relieved (H)ASME Code (Latest Edition) Code lb Estmated Weight (Empty) B (A)**Material Specification** 14" Carbon Steel Shell -None Internals -None Lining -Supports -**Heat Conservation** Insulation -18" Nozzle Schedule Rating Size, in. Mark Qty. Nozzle No. 0.75 in. 600# RF inlet Α 600# RF В 1 0.75 in. Outlet С 0.75 in. 600# RF Safety Valve 1 600# RF D 1 0.75 in. Drain 3000# NPT 1.0 in. E Level Gauge 3000# NPT F 1 1.0 in. Level Gauge 0.75 in. 3000# NPT G 1 Pressure Gauge 1 1.0 in. 3000# NPT Temperature Gauge н Remarks: 1. To be verified with air compressor vendor. 2. Ellipsoidal heads. 3. Final complete data sheet subjected to Kenox approval. PROJECT NO. DIVISION NO. PROJECT: KENOX UJ41014 IT Corporation - TNT Red Water EQUIPMENT NO. REV. CLIENT: D-103 IT Corporation 0 LOCATION: 11/21/94 For Quotation вм 0 SHEET 1 OF NO. DATE REVISION CHK. APP.

VERTICAL VESSEL DATA SHEET Equipment Name: Feed Drum **Total Number Required** Design Data 15 psia Max Operating Pressure 30 psia Design Pressure ٥F 85 Max Operating Temperature ۰F 135 Design Temperature in. Corrosion Allowance Per ASME Code Radiography Stress Relieved ASME Code (Latest Edition) Code lb Estmated Weight (Empty) (F)**Material Specification** 31655 Shell -Note (1) Internals -Lining ö Carbon Steel (skirt) Supports -Insulation -40" Nozzle Schedule (E) Size, in. Rating Nozzie Mark Qty. No. 0.50 in. 150# RF A Inlet 150# RF В 1 1.0 in. Outlet & Drain B ë 1.0 in. 150# RF С Vent D 1 1.50 in 150# RF Level Gauge 1.50 in 150# RF Ε 1 Level Gauge F 1 1.0 in. 150# RF Level Switch 8.0 in. 150# RF G 1 Hand Hole 3000# NPT Н 0.75 in. Sample Point Remarks: 1. Vortex breaker at liquid outlet to be provided. 2. Ellipsoidal heads. 3. Final complete data sheet subjected to Kenox approval. PROJECT NO. DIVISION NO. PROJECT: **KENOX** IT Corporation - TNT Red Water UJ41014 EQUIPMENT NO. REV. CLIENT: **IT Corporation** D-104 вм 1 12/22/94 Nozzle 'H' added BM LOCATION: 0 11/18/94 For Quotation SHEET 1 OF CHK. DATE **REVISION**

VERTICAL VESSEL DATA SHEET **WAO Effluent Drum Equipment Name: Total Number Required** Design Data Max Operating Pressure 15 psia 30 psia Design Pressure ۰F 107 Max Operating Temperature ۰F 160 Design Temperature in. Corrosion Allowance Per ASME Code Radiography Stress Relieved Code ASME Code (Latest Edition) lb Estmated Weight (Empty) Material Specification 31655 Shell -Note (1) Internals -Lining ö Carbon Steel (skirt) Supports -Insulation -No 40" E Nozzie Schedule (F) Mark Qty. Size, in. Rating Nozzle No. 0.50 in. 150# RF Inlet Α 150# RF Outlet & Drain В 1.0 in. (B) 1.0 in. 150# RF 'n C Vent 150# RF 1.50 in Level Gauge D Level Gauge E 1.50 in 150# RF F 1.0 in. 150# RF Level Switch G 8.0 in. 150# RF Hand Hole 0.75 in. 3000# NPT Sample Point Н Remarks: 1. Vortex breaker at liquid outlet to be provided. 2. Ellipsoidal heads. 3. Final complete data sheet subjected to Kenox approval. PROJECT: PROJECT NO. DIVISION NO. KENOX IT Corporation - TNT Red Water UJ41014 EQUIPMENT NO. REV. CLIENT: D-105 **IT Corporation** 12/21/94 Nozzle 'H' added 1 BM 11/16/94 For Quotation LOCATION: BM 5 m 0

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REVISION

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SHEET

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_				HEA	T E	XCH	IANG	ER DATA	SHEE				
•			E-101 REA	CTOR F	ED/EF	FLUENT	EXCHA	NGER					
Size			Type:	Double	Pipe		(Horiz/	Vert) Horiz.	Con	nected in			
Surf/Ur	nit		7,7	Shells/					Eff. Surf/Sh	ell			ft2
				PERFC	RMA	NCE OF	ONE L	INIT					
								SHELL	SIDE		TUBE S	SIDE	
Fluid Na	ame							Oxidized Was	tewater		Feed		
	uantity,	Total	· · · · · · · · · · · · · · · · · · ·				lb/h	200)7		154	1	
								IN	OUT	IN		OUT	
	Vapour						lb/h	1043	6	46			
	Liquid						lb/h	964	13	61	1544		1544
	Steam						lb/h						
	Water						lb/h						
	Noncor	ndensible					lb/h						
Temper	ature						٥F	483	4	03	61		362
Density	•		Liquid/	Vapour	+ NC		lb/cf	53.00/2.52	55.45/3.01	66.67	1	57.52/	
Viscosi	ty		Liquid/	Vapour	+ NC		сР	0.10/0.02	0.10/0.02	1.27/		0.10/	
Molecu	lar Weig	ht	Liquid/	Vapour	+ NC	;							
Molecu	lar Weig	ht, Nonconden	sible			_							
Specific	Heat		Liquid/	Vapour	+ NC	1	3tu/lb°F	1.19/0.44	1.08/0.33	0.91/		1.00/	
Therma	Conduc	tivity	Liquid/	Vapour	+ NC	: B1	tu/hrft-F	0.34/0.03	0.37/0.02	0.34/		0.38/	
Latent	Heat						Btu/lb						
Inlet Pro	essure						psia	990			1050		
Velocity	/						ft/s						
Pressur	e Drop,	Allow/Calc					psi	10/			20/		
	Resista						2°F/Btu	0.002			0.002		
	change		430577			Btu/	h ;MTE	(Corrected)	213			Da	°F J/hft2°F
Transfe	r Rate	Service	9	201107	DUGT	1011 05	ONE OIL	Clean	-			Btu	J/nπ2°F
							ONE SH		OVETOU		 		
				_	IELL S		T	UBE SIDE	SKETCH				
Design			psig		1090/			1160/					
	Temper		۰F		535		ļ	415					
	asses p		:-										
	on Allov	vance Size & Rating)	in			600#		600#					
		(Size & Rating)				600#	-	600#					
Tube N		; OD		Thickn		000#	<u>. </u>	Length	Pitc	h			
Tube T		Plain		THORIT				Material	Titanium				
Shell	PC	Titanium	;ID		in; O	D	in	Shell Cover			(Integ.)		
	l or Bon		,,_					Channel Cover					
	eet - St	· · · · · · · · · · · · · · · · · · ·						Tubesheet - Fl					
Floating	Head C	Cover						Impingement Pr	otection	,	yes		
Baffles	- Cross			; Type		Vert/Se	g	; %Cut(Area)	; Sp	acing c/c			in
Baffles	- Long	-						Seal Type					
Support	ts - Tub	9		. U	Bend				Туре				
Bypass	Seal Ar	rangement						Tube - Tubeshe	et Joint				
Expansi	ion Join	1						Туре					
pv2 - In	let Nozz	le	-Bu	ndle En	trance				dle exit				
Gasket	s -	Shellside						- Tubeside					
	-	Floating Head											
Code	/ Ch - II	ASME Section	VIII, Div I late	est issue		iah NA/	-4		Bun	طام			16
Weight		(4) 5	37			with Wa							Lb.
Remark		(1): Exchanger il: Shellside =					pplicable	e information to	Tully comple	te data sn	et.		
(2):		ii. Sheliside =	ritanium; Tu	beside -	- IIIai	IIUIII	T		IDDO	JECT NO.		DIVISIO	ON NO
PROJEC								KENOV	PAC		014	DIVISIO	JN NO.
II Col	porati	on - TNT Rec	water					KENOX		UJ41			
									EQU	JIPMENT S	PEC. NO).	REV.
							CLIENT			P 45			
						<u></u>		IT Corporati	on	E-10	7		0
0	94/11/21			BM		BW	LOCAT	ION:			_	0.5	Ļ
NO.	DATE	REVISIONS		BY	CHK.	APP.	I		SHE	t i	1	OF	1

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					EL	ECT	RIC HEATER			
Equip	ment Na	me	Read	ctor Feed	Heater					
	Size / Sp	ec.		0.5 in.						
Duty, I				95						
Fluid N					ed Wate	r				
Fluid O	Quantity,	Total	lb/hr	772						
	Vapour		lb/hr							
	Liquid		lb/hr	772						
	Steam		lb/hr							
	Water		lb/hr							
No	nconden	sible	lb/hr							
	erature	01210	Deg F	In:	61		Out: 480			
	ressure		psia	1050			Allowable Pressure Drop, p	si:	20	*
	ic Gravit	v	polu	1.07						
	ity, Liqui		ср	1.28						
***************************************	,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,									
					CONS	TRUCT	ION			
Design	Pressur	e ,psia		1160						
Design	Temper	ature, D	eg F	530						
Flange	Size, in:						Rating:			
Materia	al, Shell	:	Titanium	Note (7	7)	Elemen	t: Ti, non-direct contact	ct. See Note (4).		
Voltage	е									
Wattag	ge									
Length										
	heath thi		mm					· · · · · · · · · · · · · · · · · · ·		
	d Elemen									
			- Note 5			No	x Yes, Leng	ith,mm: I.D.,	mm :	
			ngs required							
	Thermo									
	ated she			raquirod?				333.7		
	ire resist	ant term	inal housing r	requireur						
Code Class:		1 & 11	Divis	ion ·	1	-	Group:			
	acturer:	1 4 11	D1010							
	Number:	•								
Wibaci	TTG: TTG: T									
Remar	ks:	1) Equip	ment vendor	to insert	all appli	cable da	ta to fully complete data shee	et.		
		2) Final	data sheet is	s subject to	Kenox	approva	al.			
		3) Auto	ignition tem	perature 2	95 to 3	30 deg (D			
		4) Heat	ing elements	to be caps	sulated :	so that p	process fluid does not come			
			ct with the e							
		5) Vend	or to supply	temperatu	re trip o	n power	supply for element high tem	peratures.		
		6) Oper	ation of the I	neater will	be inter	mittent.			· · · · · · · · · · · · · · · · · · ·	
		7) Shell	to be supplie	ed by Kend	x.					
					1-4-4-4		•			
PROJE	CT.							PROJECT NO.	DIVISION	N NO.
		TA	IT radiates				KENOX	UJ41014		
11 00	rporati	on - IF	VT redwate	- 	,		KLITOX			DE1/
	-			1	ļ	-		EQUIPMENT NO.	F	REV.
	 	ļ		-	 		CLIENT:	E-102		0
	-	5 0	-4-4	D14	-	101.1	IT Corporation	E-102		U
NO.	11/22/94	For Que	REVISION	BM	CHK	APP	LOCATION:	SHEET	1 OF	1

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				HE/	AT E	XCH/	ANG	ER DATA	SHE	ET			
Equipn	nent Nan	me	EFFLUI	ENT CO	OLER								
	-		Type:	-		-	(Horiz/\	Vert) HORIZ		Connec	cted in		
Surf/U	nit		ft2	Shells/	/Unit		· · · · · · · · · · · · · · · · · · ·		Eff. Surf				ft2
				PERF	ORMAI	NCE OF	ONE U	VIT					
								SHELL	SIDE		TUBE S	SIDE	
Fluid N	lame							Cooling Water			Oxidized Waste	e Water	
Fluid C	Quantity,	, Total					lb/h	33935	j		2007		
								IN	OUT		IN	OUT	
	Vapour	ır					lb/h	+			646		516
	Liquid						lb/h	,			1361		1491
	Steam	,					lb/h						
	Water						lb/h	33935	, <u> </u>	33935			
		ndensible					lb/h						
Tempe							٥F			86			104
Density				/ Vapour			lb/cf		,		55.45/3.01	64.66/	
Viscosi				/ Vapour			сP	1		0.797	0.1/0.02	0.76/0.	.02
	ular Weig			/ Vapour	r + NC	,			I				
		ght, Nonconden											
	ic Heat			/ Vapour			Btu/lb°F			0.97	1.078/0.331	0.946/	
	alConduc	ctivity	Liquid/	/ Vapour	r + NC	, Br	Btu/hrft-F		<u></u>	0.357	0.374/0.023	0.359/0	0.017
Latent							Btu/lb	-					
	ressure						psia	<u> </u>	,		980		
Velocit							ft/s						
		, Allow/Calc					psi				10/		
	Resista						t2°F/Btu	1			0.002		25
	xchange		588919	<u>ə</u>		Btu/	h ;MIU	Close		129		D+	%F
Transte	er Rate	Service	е			25.0	- AUC	Clean				blu	u/hft2°F
						ION OF O			T-VETCL				
	- · · · [SHELL S			TUBE SIDE	SKETCH	1			
	/ Test P		psig		720			1080/	4				
	Temper		۰F		140	<u>s</u> ,		455	4				
	Passes p			\longleftarrow			-		4				
	ion Allov		in	\longleftarrow		-200#		600#	1				
		(Size & Rating)				600#		600# 600#	4				
		t (Size & Rating)	<u>) </u>	Thickn		600#	—	600# Length		Pitch			in
Tube No.		; OD Plain		Thickin				Length Material	Titanium				
Shell	уре	Carbon Steel	;ID		in; OE			Shell Cover	Carbon S		(Integ.)		
	el or Bon		טו;		In; CL	,	in	Channel Cover		Stee	fiirea.,		
	neet - Sta							Tubesheet - Flo					
	g Head C							Impingement P			yes		
	- Cross			; Type	9			; %Cut(Area)		; Spacir			in
Baffles								Seal Type			lg 4, -		
	rts - Tub	10			U Bend	d			Туре				
Bypass	Seal Ar	rrangement						Tube - Tubeshe		_			
Expansi	sion Join	nt						Туре					
	nlet Noza		-F	Bundle F	Entrance	е			ndle exit				
Gasket		Shellside						- Tubeside					
		Floating Head											
Code		ASME Section	VIII, Div	latest				A Class	R				
Weight						with Wate				Bundle			Lb.
Remark								able information	to fully	comple	te data sheet.		
(2):		al: Shellside = C								_			
PROJEC	CT:								- 1	PROJEC	CT NO.	DIVISIO	ON NO.
IT Co	rporati	ion - TNT Red	dwater	,		,	1	KENOX			UJ41014		
<u> </u>		T			1		1			COLIIDI	MENT SPEC. NO.	.——	REV.
	-		——		+-	+	CLIENT	-		<u> </u>	AEMI SILO		NEV.
					 	+		IT Corporati	ion		E-103	4 7	
0	11/21/94	Initial		ВМ	 	AW	LOCATI	_	·			7	
	DATE			BY	CHK.	APP.		,014.	+	SHEET	1	OF	1

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		CENTR	IFU	GAL	PUM	P DATA SHEET		
Equip	ment N	ame		P-101 - V	Vaste Fe	ed Pump		
		r Required		One				
		Design Data				Motor		
Service		Raw Wastewat	er		•	Motor hp		
	/Corrosic	on				Volts 460 Phase	3 Hertz	60
			Min.	Norm	Max.	Electrical Classification	Class I & II; Div. 1	
Pump T	emperat	ure F		60				
	Gravity			1.08				
Viscosi	ty	сР		1.2078				
Vapour	Pressure	psia		14.7		Turbine		
Flow R	ate	lb/hr		772		Inlet Steam Temp.		F
Solids I	Percent	Notes 2 & 3	15		30	Inlet Steam Pressure		psia
		Pressure for Ma	x. Flo			Exhaust Steam Temp		F
Suction	Press.			16		Exhaust Steam Pressure		psia
Dischar	ge Press	ure		46	psia			
Diff. Pr				30	psi			
Diff.He				64	ft			
Min. N				5	ft			
Hyd hp		0.04 bhp				S C	-4	
		Materials				Pump Conne		
API Sp	ec 610			04000		Suction Size , Rat Discharge Size , Rat		
Case				316SS 316SS		Discharge Size , Rat	ting Ci. 3000 NT	
Shaft				316SS				
Impelle		•		31033				
Packing	nical Sea	1 Tuno						
WIECHA	ilical Sea	Турс						
		3) Consider solids abra	sive.					
PROJE		on - TNT Redwater				KENOX CLIENT: IT Corporation	PROJECT NO. UJ41014 EQUIPMENT NO. P-101	DIVISION NO. REV.
0	11/11/94	For Quotation	ВМ		BW	LOCATION:		
NO.	DATE	REVISION	BY	CHK.	APP.	1	SHEET 1	OF 1

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		CENTR	IFU	GAL	PUM	P DATA SHEET			
Equipr	nent Na	ame		P-102 - E	ilution F	eed Pump			
		Required		One					
		Design Data				Motor			
Service		Service Water				Motor hp			
	/Corrosio					Volts 460 Phase	3 Hertz	60	
			Min.	Norm	Max.	Electrical Classification	Class I & II; Div. 1		
Pump T	emperatu	ıre F		60					
	Gravity			1.015					
Viscosit		сР		1.1197					
	Pressure	psia		14.7		Turbine			
Flow Ra		lb/hr/GPM		1544/3		Inlet Steam Temp.			F
Solids F	Percent			0		Inlet Steam Pressure			psia
		Pressure for Ma	ax. Flo	w		Exhaust Steam Temp			F
Suction	Press.			16	psia	Exhaust Steam Pressure			psia
Dischar	ge Press	ure		46	psia				
Diff. Pr	ess.			30	psi				
Diff.He				68	ft				
Min. N				5	ft				
Hyd hp		0.07 bhp					-1		
		Materials				Pump Conne			
API Spe	ec 610					Suction Size , Rat			
Case			4	31655		Discharge Size , Rat	ting Ci. 3000 NPT		
Shaft				316SS					
Impelle				31655				-	
Packing	Type nical Seal								
PROJE		on - TNT Redwate	r			KENOX CLIENT:	PROJECT NO. UJ41014 EQUIPMENT NO.	DIVISION	REV.
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		POSITIVE DI	SPLA	CEN	IENT	PUMP DATA SH	HEET	
Eguipi	ment N	ame	P-103	High Pre	ssure Fe	ed Pump		
		r Required		One				
		Design Data				Motor		
Service		Raw Waste Wa	iter			Motor hp		
Erosion	/Corrosio	on				Volts 460 Phase	3 Hertz	60
			Min.	Norm	Max.	Electrical Classification	Class I, II Div.1	
Pump T	emperat	ure F		60		Variable Speed Drive Required	t: Yes	
	Gravity			1.065				
Viscosi	ty	сР		1.206				
Vapour	Pressure	e psia		14.7		Turbine		
Flow Ra	ate	lb/hr		1544		Inlet Steam Temp.		
Solids f	Percent	Notes 2 & 3	15		30	Inlet Steam Pressure		psi
		Pressure for Ma	ax. Flow	!		Exhaust Steam Temp		
Suction	Press.			20	psia	Exhaust Steam Pressure		psi
Dischar	ge Press	sure		1050	psia			
Diff. Pr	ess.			1030	psi			
Diff.Hea	ad			2224	ft			
Min. N	PSHA			5	ft			
Hyd hp		2.3 bhp						
		Materials				Pump Connec	tions	
Displac	ement C	hamber		31655		Suction Size in.		
Casing				31655		Discharge Size in.		
Plunger	Piston							
Diaphra								
	valves &	Seats		31655				
Shaft								
Packing	Туре							
Mechar	nical Sea	l Type						
Notes:								
		lier to insert all applicat			complete	e the data sheet.		
		Suspended Solids: 1 9	6 maxim	num.				
	3) Cons	ider solids abrasive.						
-						4		
PROJE	CT·						PROJECT NO.	DIVISION NO
1						KENOV		
IT Co	rporati	on - TNT Redwater				KENOX	UJ41014	<u> </u>
							EQUIPMENT NO.	REV.
						CLIENT:		
						IT CORPORATION	P-103	
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		CENTR	IFU(GAL	PUM	P DATA SHEE	T			
Equip	ment N	ame		P-105 - F	inal Efflu	ent Pump				
		r Required		One						
		Design Data				Motor				
Service		Oxidized Waste	water			Motor hp				
Erosion	/Corrosio	n .				Volts 460 Phase	3	Hertz	60	
			Min.	Norm	Max.	Electrical Classification	Cla	ss I & II; Div. 1		
Pump T	emperat	ure F		107						
	Gravity			1.03						
Viscosi		сР		0.733						
Vapour	Pressure	psia		25		Turbine				
Flow R	ate	lb/hr	772			Inlet Steam Temp.				F
Solids I	Percent	Notes 2 & 3	15		30	Inlet Steam Pressure				psia
		Pressure for Ma	x. Flor			Exhaust Steam Temp				F
Suction	Press.			18	psia	Exhaust Steam Pressure				psia
Dischar	ge Press	ure		53	psia					
Diff. Pr	ess.			35	psi					
Diff.He				78	ft					
Min. N				5	ft					
Hyd hp		0.08 bhp					41			
		Materials				Pump Cor		CL 2000 NDT		
API Sp	ec 610						Rating	CI. 3000 NPT		
Case				316SS		Discharge Size ,	Rating	CI. 3000 NF1		
Shaft				31655						
Impelle				31655						
Packing		7								
Mecha	nical Sea	Туре								
		3) Consider solids abra								
PROJE		on - TNT Redwater				KENOX		OJECT NO. UJ41014 UIPMENT NO.	DIVISIO	N NO.
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SECTION 6.0. UTILITY CONSUMPTION

Project No.: UJ41014

Revision: 1

Date: 12/22/94

Project No.: UJ41014 Revision : 1 Date :12/23/94

6.0. UTILITY CONSUMPTION

6.1. ELECTRICAL

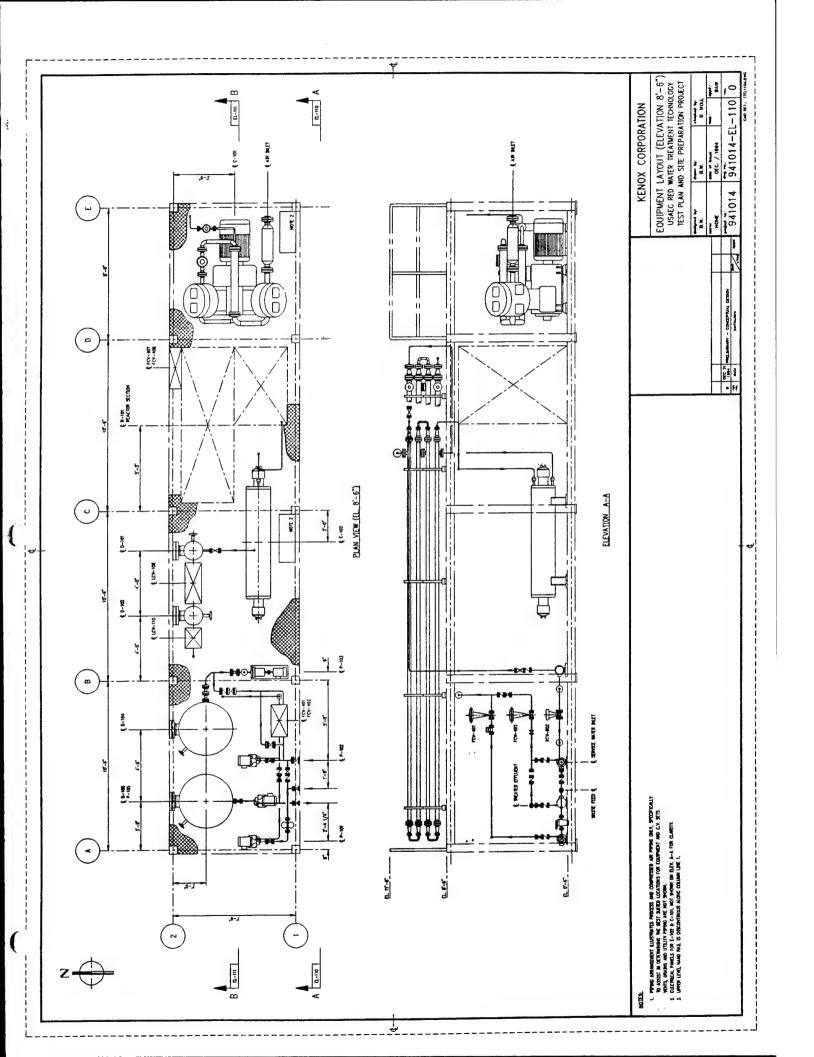
 Waste Feed Pump, KW 	0.5
 Dilution Feed Pump, KW 	0.5
• High Pressure Feed Pump, KW	1.6
 Final Effluent Pump, KW 	0.75
 Air Compressor, KW 	60
Electric Heater, KW	95
Reactor Section, KW	4

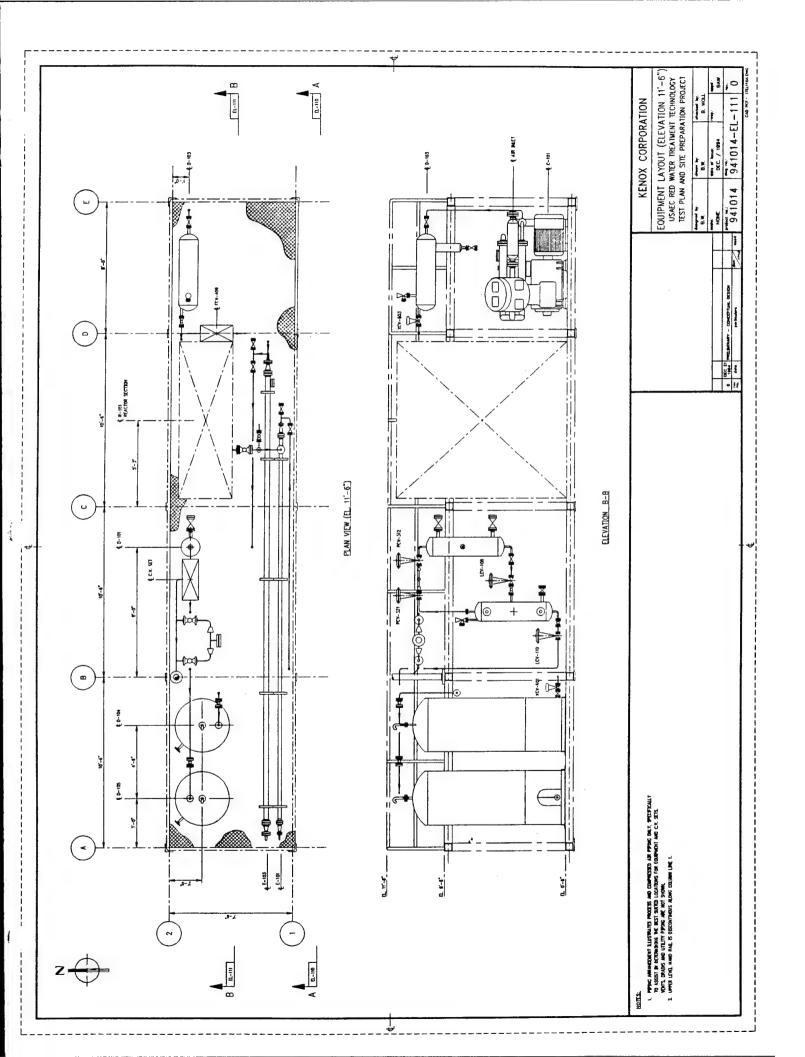
6.2. COOLING WATER

•	Effluent Cooler, USGPM	68
•	Air Compressor, USGPM	12
	Reactor Section, USGPM	15

SECTION 7.0.

GENERAL ARRANGEMENT DRAWINGS



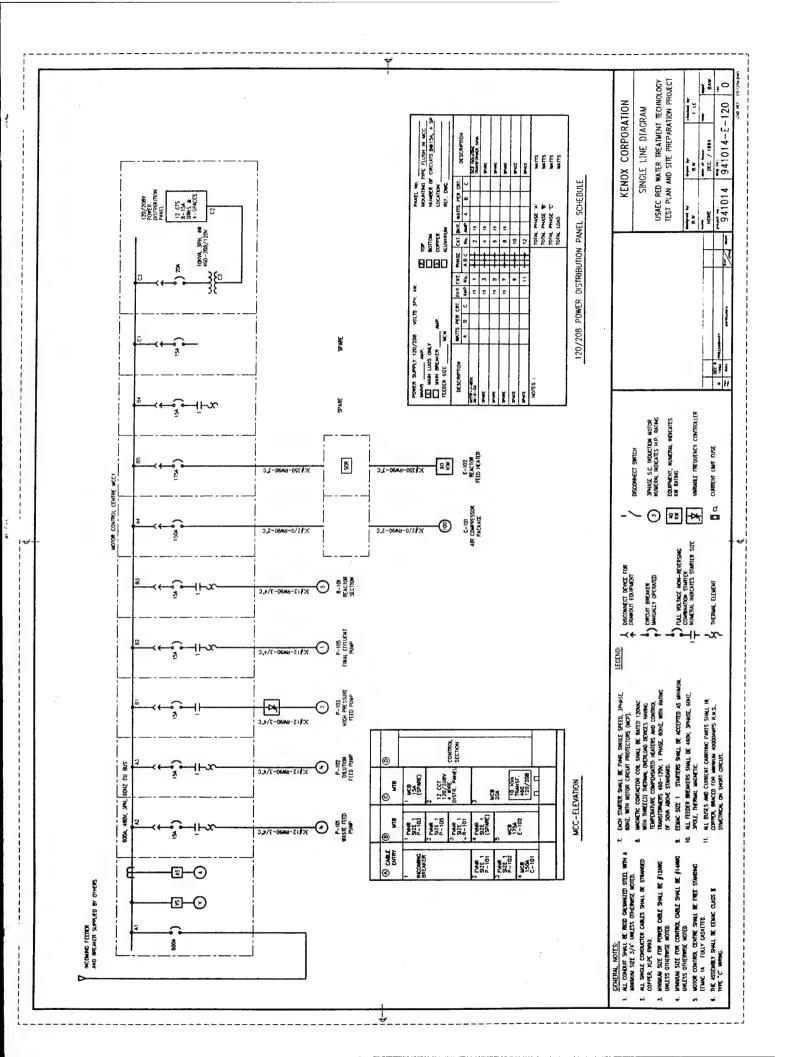


SECTION 8.0. ELECTRICAL ONE LINE DRAWING

Project No.: UJ41014

Revision: 1

Date: 12/22/94



SECTION 9.0. MASS & ENERGY BALANCE OUTPUTS

Project No.: UJ41014

Revision: 1

Date: 12/22/94

Project No.: UJ41014 Revision : 1 Date :12/23/94

9.0. MASS & ENERGY BALANCE OUTPUTS

9.1. REACTION PATHWAYS

The process modelling of the mass and energy balances for a Kenox WAO plant treating red water assumed that dinitrotoluene sulfonated compounds constitute the major COD contributor in the red water. Reaction pathways used in the process model were based on those proposed by Phull (1992) from his experimental work on the wet air oxidation of 5-nitro-o-toluene sulfonic acid (NTSA), a sulfonated aromatic similar in structure to dinitrotoluene sulfonates.

Due to limited physical data available on DNTS, the following simplified sequence of reaction pathways were assumed: (1) removal of the sulfonic group from DNTS to form dinitrotoluene and sulfuric acid and (2) oxidation of the dinitrotoluene with oxygen to produce carbon dioxide, water and nitrogen. Mass balances for sulfur and nitrogen from Phull's kinetic experiments (1992) confirm the validity of the simplified reaction pathways. The experiments indicated sulfur initially present was almost stoichiometrically converted to sulfates. For the nitrogen balance, a significant amount of nitrogen was present in the reactor offgas with an absence of nitrite and nitrate in the aqueous phase.

Reaction 1:

Reaction 2:

$$CH_3C_6H_3(NO_2)_2 + 13/2 O_2$$
 -----> $7CO_2 + 3H_2O + N_2$

(dinitrotoluene)

Experimental data reported in Phull's dissertation (1992), predict a COD conversion in the 85% range at an oxidation reaction temperature of 485 deg F.

Recommended analyses to be conducted during the pilot plant test stage to confirm the effluent characteristics are documented in Section 13.

9.2. REACTOR PROCESS CONDITIONS

Process conditions assumed for the reactors in the process simulation model are: 484 deg F reaction temperature and 1000 psia operating pressure. The raw red water feed needed to be diluted to 6% to prevent excessive evaporation in the reactors resulting from the exothermic heat of reaction released during the oxidation reaction.

SECTION 9.3.

MASS & ENERGY BALANCE OUTPUT

Project No.: UJ41014

Revision: 1

Date: 12/22/94

KENOX WAO

tion IM	Page: S-		OOLETUITS 0.0000	1.866	000.00	7.320	00	67	2.376	16	9.970	6.545	.725	.001	.000	.270	0.646	.456	0
Kenox Corporation me TEST1000.SIM	Report DILUTED TO 6%	4.	700	0.766	.000	7.320	.100	67	7E+0	999	970	545	725	100	.000	.270	46	5.456	1544.1000
Licensed to Case Na	@ 12% COD; D	لا از د	7 100	9.753	.000	7.320	0	.967	35E+0		9.970	1	.725	.001	.000	.270	46	85.45	0
Simulator HYSIM - ersion C2.50 rop Pkg PRSV	RAW RED WATER FEED	2 d G	000.	0.00.0	00.	36.823	2.050	.467	0.2051	.416	0.966	67.411	7.335	.000	00	.000	50	81.0650	772.0500*
> a	CASE: RAW			Ēų	psia	lbmole/hr	1b/hr	USGPM	Btu/hr	1b/ft3		1b/ft3	1b/hr	lb/hr	lb/hr	lb/hr	lb/hr	lb/hr	1b/hr
Hyprotech's Process Date 94/11/22 Time 15:34:49	DESIGN BASE	Stream	Vapour frac.	Temperature				low			Mole Wt.	Std Density	H20	Nitrogen	Oxygen	C02	H2S04	35NitroToluelb/	Total:

INE101SS 0.4850 483.4641 990.0001 94.8622 2007.3319 4.1547 -78511.3665 4.6516

1390.5592 368.5172 18.6829 130.4247

8.4732

MASS & ENERGY BALANCE USAEC - RED WATER

DATE:11/29/94 REVISION: 0

BY: BM

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KENOX Corporation

KENOX WAO

Hyprotech's Process Simulator HYSIM - Licensed to Kenox Corporation	Case Name TEST1000.SIM	
Simulator HYSIM -	Version C2.50	Prop Pkg PRSV
Hyprotech's Process	Date 94/11/22 1	Time 15:34:49 I

RAW RED WATER FEED @ 12% COD; DILUTED TO 6% DESIGN BASE CASE:

~

015S OUTE103SS WAOEFFLP WAOEFF 2531 0.1760 0.0004 0.0000 2996 104.0000* 106.7507 106.7507 0001 970.0000 50.0000* 25.0000 8622 94.8622 78.1686 78.1346 3319 2007.3319 1490.9379 1489.5666 2830 -1.09800E+06 -1.16006E+06 -1.16021E+06 -601 3965 16.3581 54.8231 64.4474 1605 21.1605 1389.9085 1389.8936 5592 1390.5592 1389.9085 1389.8936 5172 368.5172 0.1698 0.0008 4247 130.4247 1.6878 0.5220 6747 90.6747 90.6747 90.6747 4732 8.4732 8.4732	Stream No.	7	8	6	10	11
11a	ption	1018	1038	EFFL	AOEF	CLEF
## 403.2996	f frac.	.253	.176	.000	.000	000.
## 980.0001 970.0000 50.0000* 25.0000 94.8622 78.1686 78.1346 78.1346 78.1346 78.1346 78.1349 1490.9379 1489.5666 2.8958 2.8959 2.8936 2.8936 2.8959 2.8936 2.8936 2.8959 2.8936 2.8936 2.8959 2.8936 2.8936 2.8959 2.8936 2.8936 2.8959 2.8936 2.8936 2.8959 2.8959 2.8936 2.8959 2.8959 2.8936 2.8959 2.8959 2.8936 2.8959 2.11605 21.1605 2		403.299	04.0000	06.750	06.750	6.750
<pre>mole/hr 94.8622 94.8622 78.1686 78.1346)/hr 2007.3319 2007.3319 1490.9379 1489.5666 4.1547 4.1547 2.8969 2.8936 2.8936 3.u/hr -509088.2830 -1.09800E+06 -1.16006E+06 -1.16021E+06 -601 8.3965 16.3581 19.0734 19.0641 21.1605 21.1605 19.0734 19.0641</pre>		980.000	70.000	0000.0	25.000	000.
% Section (a) (b) (c) (c) (c) (c) (c) (c) (c) (c) (c) (c	low	94.862	4.862	8.168	8.134	0.497
GPM 4.1547 4.1547 2.8969 2.8936 2.8036 2.830 -1.09800E+06 -1.16006E+06 -1.16021E+06 -601 8.3965 16.3581 54.8231 64.4474 21.1605 21.1605 19.0641 19.0734 19.0641 65.6963 368.5172 368.5172 0.1698 0.0022 368.5172 368.5172 0.1698 0.0022 368.5172 368.5172 0.1698 0.0022 368.5172 0.0037 0.0008 368.5172 8.4732 8.4732 8.4732 368.5172 0.1698 0.0072 368.5172 0.0072 368.5172 0.1698 0.0072 368.5172 0.0072 378.6566 0.1698 0.1698 0.1698 378.772 0.1698 0.1698 378.772 0.1698 0.1698 378.773 0.1698 378	Low	007.331	007.331	490.937	89.566	2.050
.u/hr -509088.2830 -1.09800E+06 -1.16006E+06 -1.16021E+06 -601 8.3965 16.3581 54.8231 64.4474 21.1605 21.1605 19.0734 19.0641 65.6963 //hr 1390.5592 1390.5592 1389.9085 1389.8936 0/hr 18.6829 18.6829 0.0237 0.0008 0/hr 130.4247 130.4247 1.6878 0.5220 0/hr 90.6747 90.6747 90.6747 90.6747 8.4732 8.4732 8.4732	Flow	4.154	.154	.896	.893	1.4997
8.3965 16.3581 54.8231 64.4474 21.1605 21.1605 19.0734 19.0641 21.1605 21.1605 19.0734 19.0641 65.6963 //hr 1390.5592 1390.5592 1389.9085 1389.8936 //hr 18.6829 18.6829 0.0237 0.0008 //hr 130.4247 130.4247 1.6878 0.5220 //hr 90.6747 90.6747 90.6747 90.6747 //hr 2007.3319 2007.3319 1490.9379 1489.5666	λc	88.283	9800臣+06	1.16006E+0	021E+0	346.990
21.1605 21.1605 19.0734 19.0641 65.6963 1390.5592 1390.5592 1389.9085 1389.8936 368.5172 368.5172 0.1698 0.0022 368.5172 18.6829 0.0237 0.0008 3,hr 130.4247 130.4247 1.6878 0.5220 3,hr 90.6747 90.6747 90.6747 90.6747 3,hr 2007.3319 2007.3319 1490.9379 1489.5666		.396	6.358	4.823	4.447	4.447
J/ft3 65.6963 J/hr 1390.5592 1390.5592 1389.9085 1389.8936 J/hr 368.5172 368.5172 0.1698 0.0022 J8.6829 0.0237 0.0008 J/hr 130.4247 130.4247 1.6878 0.5220 J/hr 90.6747 90.6747 90.6747 90.6747 J/hr 2007.3319 2007.3319 1490.9379 1489.5666	٠.	1.160	1.160	9.073	9.064	.064
) hr 1390.5592 1390.5592 1389.9085 1389.8936 0.0022 0.1698 0.0022 0.0022 0.1698 0.0022 0.0022 0.0237 0.0008 0.0023 0.0237 0.0008 0.5220 0.0237 0.0008 0.5220 0.052 0.052 0.0008 0.5220 0.052 0.0	ty	1 1	1	ı	5.696	5.696
368.5172 368.5172 0.1698 0.0022 368.5172 18.6829 0.0237 0.0008 18.6829 18.6829 0.0237 0.0008 3.0.6747 130.4247 1.6878 0.5220 3.0.6747 90.6747 90.6747 90.6747 3.0.6747 90.6747 90.6747 90.6747 3.007.3319 2007.3319 1490.9379 1489.5666	i	90.559	390.559	89.908	89.893	0.390
18.6829 18.6829 0.0237 0.0008 130.4247 130.4247 1.6878 0.5220 10.6747 0.6747 0.6747 0.6747 0.6747 10.6747 0.6747 0.6747 0.6747 0.6747 10.6747 0.6747 0.6747 0.6747 0.6747 10.6747 0.6747 0.6747 0.6747		68.517	68.517	.169	.002	.001
)/hr 130.4247 130.4247 1.6878 0.5220)/hr 90.6747 90.6747 90.6747 90.6747)/hr 8.4732 8.4732 8.4732)/hr 2007.3319 2007.3319 1490.9379 1489.5666		18.682	8.682	.023	.000	000.
%) hr 90.6747 90.6747 90.6747 90.6747 90.6747 90.6747 90.674732 8.4732 8.4732 8.4732 8.4732 90.6747 90.6747 90.6747	lb/hr	30.424	30.424	.687	.522	.270
%,hr 8.4732 8.47	lb/hr	0.674	0.674	0.674	0.674	966.
\hr 2007.3319 2007.3319 1490.9379 1489.5666	\sim	.473	.473	.473	.473	.391
	\sim	07.331	007.331	490.937	89.566	.050

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USAEC - RED WATER
MASS & ENERGY BALANCE
REVISION: 0 DATE:11/29/94
BY: BM

KENOX WAO

Hyprotech's Process Simulator HYSIM - Licensed to Kenox Corporation Date 94/11/22 Version C2.50 Case Name TEST1000.SIM Time 15:34:49 Prop Pkg PRSV

RAW RED WATER FEED @ 12% COD; DILUTED TO 6% DESIGN BASE CASE:

 $^{\circ}$

8 OR10		000	8.031	LO	0.535	.024	3.720	9 6		0.0	8.343	53.271	00.00	000	.000	.615
17 AIRTOTAL		1000.0000*	16.0624	463.2300*	1.0704	78070.0490	3.7205	28.8394		.000	56.	.542	.000	00	.0000	00
면된	4.762	.000	6.727	7.765	.261	16	.110	25		.665	368.5150	.682	9.902	.000	00	2
450	4.670	.000	6.693	6.394	1.257	.750	.110	33	1	.650	368.3473	629.	8.736	.000	.000	516.3940
12 PRODUCT 0.0000	6.75	\circ	37.63	7.51	1.39	1.01	4.44	90.6	ω	9.50	\circ	$\overline{}$	in	/	$^{\circ}$	717.5166
Stream No. Description Vapour frac.	ure	Pressure psia	3	Tow	FLOW	Enthalpy Btu/hr			Std Density jb/ft3	ı	Nitrogen lb/hr	gen lb/	\succeq	\geq	35NitroToluelb/hr	Total: lb/hr

USAEC - RED WATER

DATE:11/29/94

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KENOX WAO

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orporat	Denort	TO 6%	71
Hyprotech's Process Simulator HYSIM - Licensed to Kenox Corporation Date 94/11/22 Version C2.50 Case Name TEST1000.SIM		DESIGN BASE CASE: RAW RED WATER FEED @ 12% COD; DILUTED TO 6%	
sed to Jase Na		COD; I	c
Licens		@ 12%	
IM - 1		FEED (
or HYS	PRSV	VATER	0
mulato	Prop Pkg PRSV	RED V	
ss Sir	Proj	RAW	
Proce/22	:49	CASE:	
otech's Pro 94/11/22	15:34	BASE	Ų.
Hyprote Date	Time	DESIGN	Of mean

ŝ

	•			
Stream No.		19	20	21
Description		AIRTOR102	CMIN	CWOUT
Vapour frac.		1.0000	0.000.	0.000
Temperature	ĒL,	255.0000	*0000.89	*0000*
Pressure	psia	1000.0001	*0000.09	50.0000
	lbmole/hr	8.0312	1883.6746	1883.6746
Mass Flow	lb/hr	231.6150	33934.5875	33934.5875
ol Flow	USGPM	0.5352	67,9084	
, by	Btu/hr	39035.0245		2.7
ty	1b/ft3	3.7205	63.1274	
Mole Wt.		28.8394	18.0151	
Density			63.3284	
H20	1b/hr	0.000.	33934.5874*	33
rogen	1b/hr	178.3435	*0000.0	0.000
	1b/hr	53.2715	*0000.0	
C02	lb/hr	0.000.0	*0000.0	
H2SO4 1b	lb/hr	0.000.0	*0000.0	
35NitroTolue	_	0.000	*0000.0	
Total:	lb/hr	231,6150	33934.5875	

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KENOX Corporation

USAEC - RED WATER MASS & ENERGY BALANCE REVISION: 0 DATE:11/29/94 BY: BM

SECTION 10.0. PILOT PLANT COST ESTIMATES

Project No.: UJ41014

Revision: 1

Date: 12/22/94

10.0. PILOT PLANT COST ESTIMATE

10.1. SCOPE OF KENOX SUPPLY

Kenox shall supply IT Corporation's client with the following services and equipment:

- Basic Process Engineering Design Package.
- Detailed engineering, procurement, manufacturing/fabrication and assembly of the total Kenox skid mounted system.
- Kenox' skid mounted system includes all equipment as per the equipment list in Section 4, fabrication and installation of piping within the skid battery limit and instrumentation.
- Separate trailer unit to contain DCS and MCC.
- All vessels and piping within the skid battery limits requiring insulation will be insulated.
- All electrical equipment and materials within the skid arrangement to be preinstalled and terminated at junction boxes.
- Operating and maintenance manuals.

10.2. SCOPE OF IT CORPORATION SUPPLY

IT Corporation or its client shall supply the following equipment and services:

- Foundation and drainage system to accommodate Kenox skid mounted system.
- All utility connections to and from Kenox system.
- Unpacking and locating the skid in the designated area.
- Electrical interconnecting wiring and conduit between skid mounted Kenox supplied junction boxes and Kenox supplied trailer unit.
- Power feed to Kenox disconnect switch at power distribution panel.
- Appropriate system registration with governing State authorities.

10.3. PURCHASE OPTION

The price for a fully operational skid mounted plant capable of treating TNT red water in a continuous operation at the rate of 3 USGPM delivered CIF Toronto, Ontario, Canada is \$ 1,900,000 US - 5% + 15 %. This price is valid for 90 days from the date of this proposal.

The cost of shipment, insurance, transportation to IT Corporation or its client and all applicable federal and state taxes and permits will be on the account of the purchaser.

The price quoted includes the scope of supply by Kenox Corporation as outlined in Section 10.1.

10.4. LEASE OPTION

The cost schedule for the leasing option is outlined below:

- 4 equal payments of \$225,000 US
- first payment due upon signing of the purchase order
- · second payment due on delivery of the equipment to the site
- third payment due 90 days after delivery of the equipment to the site
- fourth payment due 120 days after delivery of the equipment to the site
- the cost of shipment, insurance, transportation to IT Corporation or its client and return to Kenox and all applicable federal and state taxes and permits will be on the account of the purchaser.
- operations and maintenance costs not included

The leasing cost and terms are valid for 90 days from the date of this proposal.

Kenox will be pleased to provide additional information, if required, at the time the contract is negotiated.

SECTION 11.0. OPERATIONS & SAFETY CONSIDERATIONS

11.0. OPERATIONS & SAFETY CONSIDERATIONS

11.1. INTRODUCTION

This section presents a description of special health and safety precautions related to the operations and sampling of a Kenox Wet Air Oxidation system for the treatment of red water.

11.2. REGULATIONS AND GUIDELINES

All activitities conducted during the wet air oxidation of red water must be in compliance with applicable requirements of the following publications:

- 29 Code of Federal Regulations (CFR) 1926, Construction Industry, OSHA Safety and Health Standards
- 29 CFR 1910, General Industry OSHA Safety and Health Standards
- 29 CFR 1910.120, OSHA Final Rule dated March 6, 1989, "Hazardous Waste Operations and Emergency Response"
- NIOSH/OSHA/USCG/EPA, "Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities,", October 1985
- American Conference of Government Industrial Hygienists (ACGIH),
 "Threshold Limit Values and Biological Exposure Indices", 1989 1990, or most current version
- U.S. Department of Health and Human Services, (DHHS) "NIOSH Sampling and Analytical Methods," DHHS (NIOSH) Publication 84-100
- ANSI, Emergency Eyewash and Shower Equipment, Z41.1 (1983)
- ANSI, Protective Footwear, Z358.1 (1981)
- ANSI, Practice for Occupational and Educational Eye and Face Protection, Z87.1 (1968)
- ASTM D4687, Vol. 11.04, Standard Guide for General Planning of Waste Sampling, ASTM, Philadelphia, PA.

11.3. EMERGENCY SHUTDOWN SYSTEM

The prime area of concern is the reaction of the excess oxygen in the reactor system with an inadvertent introduction of an excess of oxidizable chemicals or a material (such as a combination of copper, iron and cobalt) that could act as a catalyst and increase the rate of reaction. The rapid oxidation would result in an increase in the reaction temperature and a corresponding increase in pressure. However, the pressure increase would be mitigated by the pressure control valve PCV-312 opening in response to the pressure surge.

The system is equipped with two levels of alarm. The first alarm, with indication on the CRT, warns of high temperature or high pressure in the system prior to activation of the Emergency Shutdown System.

The second alarm on high temperature or high pressure reading in the reactor system will trigger the Emergency Shutdown System. If the temperature sensor, TSHH-208, on the the reactor system's outlet line senses a temperature over 500 °F (Note: this setting can be changed) or the high pressure sensor, PSHH-313, on the reactor system's outlet line senses a pressure over 1050 psig (resulting from a rapid pressure rise or a malfunction of pressure control valve, PCV-312), the WAO system will go into automatic shutdown as follows:

- 1. High temperature alarm is sounded with an indication on the CRT in the control room as to which sensor has activated the shutdown.
- 2. The microprocessor control unit will automatically initiate the following steps simultaneously:
 - Air to system is stopped by the closing of the emergency shutdown valve XCV-603 located on the outlet line from the air accumulator, D-103.
 - If the electric heater E-102 is in use, a signal will be sent to shut down the heater to prevent any additional heat from being introduced into the system.
 - The waste water feed to the system is stopped by closing of the feed shutdown valve XCV-601 located upstream of the high pressure feed pump, P-103.
 - Service water is introduced to the system by the full opening of the valve XCV-602 located upstream of P-103.

The operator should proceed as follows:

• Acknowledge the alarm.

- Lower the pressure on the system to 900 psig by resetting PCV-312.
- Increase the flow through the high pressure pump, P-103 to 4 USGPM.

All the above steps can be done from the CRT in the control room.

If the pressure and temperature sensors fail to respond or a fault occurs in the control system, then the pressure will be relieved via the safety relief valve PSV-317. A high pressure alarm, PAH-316 would indicate that either the relief valve has been activated or that the rupture disc is leaking. The relief valve will discharge to the atmosphere via a safe location. If the relief valve is activated then the operator should immediately implement the shutdown of the facility via pushing button HS-XXX on the panel or an equivalent icon on the CRT. The rupture disc PSE-314 should be replaced, relief valve settings rechecked and lines between the rupture disc and the safety valve cleaned to remove any residual waste lodged against PSH-316 and PI-315.

11.4. HAZARD ASSESSMENT

11.4.1 Waste Feed

Explosion Potential - Red water has a solids content of 15% and a solids heat content of 3200 BTU/lb. As the initial raw waste stream will be diluted with a recycle effluent stream and a very high reactor recycle stream prior to entering the reactor system (exceeding the 20:1 dilution factor), the effects of temperature and pressure excursions resulting from a detonation type of reaction is negligible. Section 11.3 discusses the Emergency Shutdown System in place to handle temperature and pressure excursions.

Contaminated Surfaces - The raw red water will be pumped to the feed drum from the client's storage tank located outside Kenox' battery limits. In the unlikely event that red water is spilled or leaked, it should be cleaned using wet methods and not be allowed to dry. If it is allowed to dry, the concentrated solids must be considered as explosive and susceptible to initiation by impact, friction, heat or electrostatic charge.

11.4.2 Burn Hazards

All equipment with surface temperatures over 100 deg F have been provided with insulation for personnel protection.

11.4.3 Confined Space Entry

The WAO system shall be evaluated during detailed engineering to determine if any spaces are permit required confined space. A permit required confined space is a space that:

- Contains or has the potential to contain a hazardous atmosphere
- Contains a material that has a potential for engulfing an entrant
- Is configured such that an entrant could be trapped or asphyxiated
- Contains any other safety or health hazard.

A sign reading, "DANGER - PERMIT - REQUIRED CONFINED SPACE, DO NOT ENTER" will be posted at the entrance to any confined space.

11.4.4 Sampling

Red water may present potential inhalation and skin contact hazards during the sampling and sample handling activities. Appropriate personal protective equipment should be worn (i.e. safety glasses, hand protection, apron). Material Safety Data Sheets on some major components of red water are presented in Section 11.4.5.

SECTION 11.4.5. MATERIAL SAFETY DATA SHEETS

Project No.: UJ41014

Revision: 1

Date: 01/09/95

MSDS Canadian Centre for Occupational Health and Safety

*** IDENTIFICATION ***

MSDS RECORD NUMBER : 347777

PRODUCT NAME(S)

: TNT

PRODUCT IDENTIFICATION : EXP 0032

*** MANUFACTURER INFORMATION ***

MANUFACTURER

: ICI Canada Inc

ADORESS

: 90 Sheppard Avenue East Box 200 Station "A" North York Ontario Canada M2N 6H2

Telephone: 416-229-7000

Telex: 06986505 Fax: 416-229-7752

EMERGENCY TELEPHONE NO.: 800-561-3636

*** MATERIAL SAFETY DATA ***

ICI Canada Inc. P.O. Box 200, Station "A" North York, Ontario Canada, M2N 6H2

TNT

MATERIAL SAFETY DATA SHEET

Date Issued: 91 06 06

Index: EXP 0032/91B

FOR EMERGENCIES INVOLVING CHEMICAL SPILL OR RELEASE, CALL THE ICI CANADA TRANSPORTATION EMERGENCY RESPONSE SYSTEM AT 1-800-561-3636.

PRODUCT IDENTIFICATION

Product Name: TNT

Chemical Name: 2,4,6-Trinitrotoluene

Synonyms: Methyltrinitrobenzene, alpha-TNT, Nitropel, TNT (TY1 Flake) (Military Grade), TNT (Flake). Triton, Trinitrotoluol, Trotyl, Tolite.

Trinitrotoluene.

Chemical Family: High Explosives. Molecular Formula: (NO2)3C6H2CH3

Product Use: Blasting agent. Manufacture of packaged explosives and primers

(cast explosive).

REGULATORY SECTION

Controlled Products Reculations Classification: This product is an explosive and is not regulated by SMMIS.

OSHA Hazard Communica: (29CFR 1910.1200) Classification: Ir: eye. skin and respiratory tract); skin sensitizer; explosive.

CANADIAN TOG ACT SHIPPING DESCRIPTION

Shipping Name: Trinitrotoluene (or TNT)

Shipping Class/Division: 1.1D

Product Identification No (PIN): UN0209

Packino Group: II

U.S. DOT Classification: Refer to the "Code of Federal Regulations."

Other Regulations: Not available.

Read the entire MSDS for the complete hazard evaluation of this product.

HAZARDOUS INGREDIENTS OF PRODUCT

ACGIH

Hazardous Inoredients %(w/w)

TLV

CAS No.

Trinitrotoluene

98-100 0.5 mg/m3

118-96-7

PHYSICAL PROPERTIES

Physical State: Solid.

Appearance and Odour: Pale yellow flakes or prills; practically odourless.

Odour Threshold: Not applicable.

Boiling Range (Deg. C): Decomposes at 270.

Melting/Freezing Point (Deg. C): 80.65 (pure TNT)

Vapour Pressure: 0.053 mmHq (@ 85 Deg. C).

Specific Gravity: 1.645 (crystals): 1.47 (molten) (water = 1).

Vapour Density: Not available.

Bulk Density: 0.94 g/cc

Evaporation Rate: Not applicable.

Solubility: 0.013 g/100 g of water at 20 Deg. C. Sparingly soluble in

alcohol; soluble in benzene, toluene and acetone.

% Volatile by Volume: Not applicable.

pH: Not applicable.

Coefficient of Water/Oil Distribution: Not available.

Sensitivity to Mechanical Impact: One of the least sensitive of the high

explosives. More sensitive in the liquid form than the solid.

Rate of Burning: Not available.

Explosive Power: 439 kJ/100 a

Sensitivity to Static Discharge: Not available.

REACTIVITY DATA

Stability:

Under Normal Conditions: Stable.

Under Fire Conditions: Flammable.

· Hazardous Polymerization: Will not occur.

Conditions to Avoid: Excessive heat, situations where product may be

confined, and prolonged exposure to sunlight.

Materials to Avoid: Strong oxidizers and reducing agents, alkaline materials at the sine of the strong oxidizers and reducing agents, alkaline materials

Harm dows Decomposition or Combustion Products: When heated to decomposition, it emits toxic nitrogen oxide (NOx) fumes. Its combustion products include large amounts of black smoke and nitrogen oxide fumes (NOx).

ETRE AND EXPLOSION DATA

Flash Foint (Deg. C) (Method): Not available.
Autoignition Temperature: Approx. 295-330 Deg. C.
Flammability Limits in Air (%): LEL: Not applicable.
UEL: Not applicable.

Fire Extinguishing Media: See below.

Fire Fighting Procedures: DO NOT FIGHT FIRES INVOLVING EXPLOSIVE MATERIALS. Immediately evacuate all personnel from the area.

Other Fire or Explosion Hazards: Not applicable.

TOXICOLOGICAL AND HEALTH DATA

Recommended Exposure Limit: See "HAZARDOUS INGREDIENTS OF PRODUCT" Section.

Toxicological Data:

Trinitrotoluene LD50 (oral, rat) = 795 mg/kg (1)

Carcinogenicity Data: The ingredient(s) of this product is (are) not classified as carcinogenic by ACGIH (American Conference of Governmental Industrial Hygienists) or IARC (International Agency for Research on Cancer), not regulated as carcinogens by OSHA (Occupational Safety and Health Administration), and not listed as carcinogens by NTP (National Toxicology Program).

Reproductive Effects: No information is available and no adverse reproductive effects are anticipated.

Mutagenicity Data: No information is available and no adverse mutagenic effects are anticipated.

Teratogenicity/Fetotoxicity Data: No information is available and no adverse teratogenic/embryotoxic effects are anticipated.

Syneroistic Materials: None known.

EFFECTS OF EXPOSURE WHEN:

- . Inhaled: Product is irritating to the nose, throat and respiratory tract. May cause central nervous system (CNS) depression, liver damage, kidney damage and methemoglobinemia. See "Other Health Effects" Section.
- . In contact with the skin: This product may cause irritation due to

abrasive action. Prolonged and repeated contact may lead to dermetitis. May be absorbed through intact skin. May cause skin sensitization or other alleroic responses. See "Other Health Effects" Section.

- . In contact with the eyes: This product causes irritation, redness and pain. Prolonged and repeated contact may cause cataracts.
- . Ingested: Ingestion of large amounts may cause nausea, gastrointestinal upset and abdominal pain. May cause central nervous system (CNS) depression, liver damage, kidney damage and methemoglobinemia. See "Other Health Effects" Section.

Other Health Effects: Initial manifestation of methemoglobinemia is cyanosis, characterized by navy blue, almost black lips, tongue, and mucous membranes, with skin colour being slate gray. Further manifestation is characterized by headache, weakness, dyspnea, dizziness, stupor, respiratory distress and death due to anoxia.

Signs and symptoms of kidney damage generally progress from oliguria, to blood in the unine, to total renal failure.

If ingested, Nitrates may be reduced to nitrites by bacteria in the digestive tract. Signs and symptoms of nitrite poisoning include cyanosis (due to methemoglobin formation), nausea, dizziness and increased heart rate.

CNS depression is characterized by headache, dizziness, drowsiness, nausea, vomiting and incoordination. Severe overexposures may lead to coma and possible death due to respiratory failure.

Sensitization is the process whereby a biological change occurs in the individual because of previous exposure to a substance and, as a result, the individual reacts more strongly when subsequently exposed to the substance. Once sensitized, an individual can react to extremely low airborne levels, even below the TLV, or to skin contact.

FIRST AID PROCEDURES WHEN:

- . Inhaled: Move victim to fresh air. Give artificial respiration ONLY if breathing has stopped. Give cardiopulmonary resuscitation (CPR) if there is no breathing AND no pulse. Obtain medical attention IMMEDIATELY.
- . In contact with the skin: Flush skin with running water for a minimum of 20 minutes. Start flushing while removing contaminated clothing. If irritation persists, repeat flushing. Obtain medical attention IMMEDIATELY.
- . In contact with the eyes: Immediately flush eyes with running water for a minimum of 20 minutes. Hold eyelids open during flushing. If irritation persists, repeat flushing. Obtain medical attention IMMEDIATELY.
- . Ingested: If victim is alert and not convulsing, rinse mouth out and give 1/2 to 1 glass of water to dilute material. DO NOT induce vomiting. If spontaneous vomiting occurs, have victim lean forward with head down to avoid breathing in of vomitus, rinse mouth and administer more water. Obtain medical attention IMMEDIATELY.

Emergency Medical Care: Alcohol use may cause enhanced response to effects

of TMT exposure. Individuals deficient in glucose-6-phosphate dehydrogenase may be at greater risk. Medical conditions that may be aggravated by exposure to this product include cardiovascular diseases and liver, blood and kidney disorders.

PREVENTATIVE MEASURES

Recommendations listed in this section indicate the type of equipment which will provide protection against overexposure to this product. Conditions of use, adequacy of engineering or other control measures, and actual exposures will dictate the need for specific protective devices at your workplace.

Engineering Controls: Local exhaust ventilation required, if the product itself is handled.

Respiratory Protection: A NIOSH/MSHA-approved air-purifying respirator equipped with combined dust, mist, fume/organic vapour cartridges for concentrations up to 5 mg/m3 TNT. An air-supplied respirator if concentrations are higher or unknown.

Skin Protection: Gloves and protective clothing made from cotton should be impervious under conditions of use. The use of coveralls is recommended.

Eye Protection: Safety glasses with side shields are recommended to prevent eye contact.

Other Personal Protective Equipment: Locate safety shower and eyewash station close to chemical handling area.

Handling Procedures and Equipment: This product is an explosive and should only be used under the supervision of an experienced blaster.

Storage Temperature (Deg. C): See below.

Storage Requirements: Dry, secure magazine that is properly grounded. Do not expose to temperatures above 35 Deg. C.

Other Precautions: Use only with adequate ventilation and avoid breathing dusts/vapours. Avoid contact with eyes, skin or clothing. Wash thoroughly with soap and water after handling. Wash contaminated clothing thoroughly before re-use.

ENVIRONMENTAL PROTECTION DATA

Steps to be Taken in the Event of a Spill or Leak: Stop and contain spill. Wet spilled material and sweep up into strong plastic bags or plastic containers. Keep the material wet. Avoid use of metal tools. Be careful to avoid shock, friction and sparks. Notify applicable government authority if release is reportable or could adversely affect the environment.

Environmental Effects: Harmful to aquatic life at low concentrations. A concentration of 1.5 mg/L is toxic to fish. Can be dangerous if allowed to enter drinking water intakes. Product has an unaesthetic appearance and can be a nuisance.

Deactivating Chemicals: None known.

Waste Disposal Methods: Do not dispose of waste with normal garbage — to sewer systems. Burn under supervision of an expert at a government approved explosive burning ground or destroy, by detonation in boreholes, with explosives in accordance with applicable local, provincial and federal regulations. Call upon the services of an ICI Technical Representative.

ADDITIONAL INFORMATION AND SOURCES USED

- 1. RTECS-Registry of Toxic Effects of Chemical Substances, On-line search, Canadian Centre for Occupational Health and Safety RTECS database, Vol I-V, 1985-1986 edition, Doris V. Sweet, Ed., National Institute for Occupational Safety and Health, U.S. Dept. of Health and Human Services, Cincinnati, 1987.
- $2.\,$ U.S. Dept. of Health and Human Services, NIOSH/OSHA Occupational Health Suidelines for Chemical Hazards, NIOSH, U.S. Dept. of Labour, 1978.

M. Explosives, R. Meyer, 2nd Edition, 1981, Verlag Chemie.

- 4. M.W. Nay et al, J. Wat. Pollut. Control Fed., 1974, Volume 46, 485-497.
- 5. Formula Book Explosives, C-I-L Inc., Explosives, Research and Technical Department, current Editon.
- 6. Chemistry and Technology of Explosives, Vol. 1, T. Vrbanski, Pergamon Press, 1983.
- 7. Windholz, Martha, Ed., The Merck Index, 10th ed., Merck and Co. Inc., Rahway, New Jersey, 1983.
- 8. Sax. N. Irving, Dangerous Properties of Industrial Materials, 7th ed., Van Nostrand Reinhold Co., New York, 1989.

The information contained herein is offered only as a guide to the handling of this specific material and has been prepared in good faith by technically knowledgeable personnel. It is not intended to be all-inclusive and the manner and conditions of use and handling may involve other and additional considerations. No warranty of any kind is given or implied and ICI Canada Inc. will not be liable for any damages, losses, injuries or consequential damages which may result from the use of or reliance on any information contained herein. This Material Safety Data Sheet is valid for three years.

Date Issued: 91 06 06
Date Revised: 91 06 06
MSDS Index No: EXP 0032/918

Prepared By: Safety, Health and Environment (416) 229-8252

MSDS * Canadian Centre for Occupational Health and Safety *** IDENTIFICATION *** MSDS RECORD NUMBER : 690925 PRODUCT NAME(G) : DNT Mixture Dinitrotoluene Mixture PRODUCT IDENTIFICATION : MSDS NUMBER: CECOO012 DATE OF MSDS : 1992-11-07 *** MANUFACTURER INFORMATION *** MANUFACTURER : DuPont Canada, Inc ADDRESS : Post Office Box 2200 Streetsville Mississauga Ontario Canada L5M 2H3 Telephone: 800-387-2122 (Product Information) EMERGENCY TELEPHONE NO.: 613-348-3616 (Transport, 24 Hours) 613-348-3616 (Medical, 24 HOURS) *** SUPPLIER/DISTRIBUTOR INFORMATION *** SUPPLIER/DISTRIBUTOR : DuPont Canada, Inc ADDRESS : Post Office Box 2200 Streetsville Mississauoa Ontario Canada L5M 2H3 Telephone: 800-387-2122 (Product Information) EMERGENCY TELEPHONE NO.: 613-348-3616 (Transport, 24 HOURS) 613-348-3616 (Medical, 24 HOURS) *** MATERIAL SAFETY DATA *** DuPont Page 1 Material Safety Data Sheet Dinitrotoluene Mixture Revised 7-NOV-1992 CEC00042 Printed 3-FEB-1994 CHEMICAL PRODUCT/COMPANY IDENTIFICATION Material Identification : 25321-14-6 : CH3C6H3(NO2)2 CAS Number

Formula CAS Name

: Benzene, methyl dinitro : Technical

Grade

Tradenames and Synonyms

DNT Mixture

Company Identification

MANUFACTURER/DISTRIBUTOR

DuPont Canada, Inc. P.O. BOX 2200 STREETSVILLE MISSISSAUGA, ONTARIO L5M 2H3

PHONE NUMBERS

Product Information: 1-800-387-2122

Transport Emergency : 1-613-348-3616 (24 HOURS)
Medical Emergency : 1-613-348-3616 (24 HOURS)

COMPOSITION/INFORMATION ON INGREDIENTS

Components

* Regulated as a Toxic Chemical under Section 313 of Title III of the Superfund Amendments and Reauthorization Act of 1986 and 40 CFR part 372.

HAZARDS IDENTIFICATION

Potential Health Effects

Harmful if inhaled or absorbed through skin; causes cyanosis. Symptoms may be delayed. Causes irritation.

Inhalation 1-hour LC50: >2.87 mg/l in rats - Data is Skin absorption ALD: >1,000 mg/kg in rabbits for Oral LD50: 177 mg/kg in rats 2,4-DNT CECOOO12 DuPont

Material Safety Data Sheet

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(HAZARDS IDENTIFICATION - Continued)

2,4-DNT is an eye and skin irritant. Toxic effects described in animals from short exposures include nonspecific effects such as reduced weight gain, methemoglobinemia and effects on the central nervous system, the reproductive system, and the bone marrow. In tests with laboratory animals, technical grade 2,4-DNT has carcinogenic activity. Tests for mutagenic activity in bacterial and mammalian cell cultures have been inconclusive, with positive results in some studies, and negative results in others. Tests in animals demonstrate no developmental activity. 2,4-DNT produce testicular degeneration and decreased spermatogenesis in rats, mice, and dogs. Reduction in male fertility occurs in dominant lethal studies in rats.

2,6-DNT is a skin irritant, is not an eye irritant, and is a skin sensitizer in tests with laboratory animals. effects described in animals from exposure include methemoglobinemia, decreased spermatogenesis. testicular atropy, anemia, paralysis and tremors. Tests with 2,6-DNT in some animals demonstrte carcinogenic activity, while tests for mutagenic activity in bacterial and mammalian cell cultures have been inconclusive with positive results in some studies, and negative results in others.

Human health effects of overexposure may initially include: reduction of the blood's oxygen carrying capacity with cyanosis (bluish discoloration), weakness, or shortness or breath by methemoglobin formation; abnormal blood forming system function with anemia; red blood cell destruction; nonspecific discomfort, such as nausea, headache or weakness; temporary nervous system depression with anaesthetic effects such as dizziness, headache, confusion, incoordination, and loss of consciousness; temporary lung irritation effects with cough, discomfort, difficulty breathing, or shortness of breath; or joint pain. All isomers appear to be able to significantly permeate the skin. There are no reports of human sensitization. Individuals with preexisting diseases of the cardiovascular system or bone marrow may have increases susceptibility to the toxicity of excessive exposures.

Carcinogenicity Information

The following components are listed by IARC, NTP, OSHA or ACGIH as carcinogens. A "P" indicates a proposed carcinogen.

Material Dinitrotoluene Mixture 2.4-Dinitrotoluene

IARC NTP OSHA ACGIH

Х Х

Du Pont controls the following materials as potential carcinogens: 2,4-Dinitrotoluene. DuPont

CEC00012 Material Safety Data Sheet Page 3

FIRST AID MEASURES

First Aid

In case of contact: Immediately flush eyes or skin with plenty of water for at least 15 minutes while removing contaminated clothing and shoes. Call a physician. clothing before reuse and destroy contaminated shoes.

If inhaled: Remove to fresh air. If not breathing, give artificial respiration, preferably mouth-to-mouth. If breathing is difficult, give oxygen. Call a physician.

If swallowed: Induce vomiting immediately by giving two glasses of water and sticking finger down throat. Call a physician. Never give anything by mouth to an unconscious person.

Note to Physician: Absorption of this product into the body leads to the formation of methemoglobin which, in sufficient concentration, causes cyanosis. In case of skin absorption, symptoms may be delayed. Since reversion of methemoglobin to hemoglobin occurs spontaneously after termination of exposure, moderate degrees of cyanosis need be treated only by supportive measures such as bed rest and oxygen inhalation. Thorough cleansing of the entire contaminated area of the body including scalp and nails is of utmost importance. If cyanosis is severe, intravenous injection of methylene blue, 1 mg/kg body weight, may be of value. Cyanocobalamin (Vitamin B-12), 1 mg intramuscularly, will speed recovery. Intravenous fluids and blood transfusions may be indicated in very severe exposures.

FIRE FIGHTING MEASURES

Flammable Properties

Flash Point : 173 C (343 F)

Method : SFCC

Flammable limits in Air, % by Volume

LEL : *
UEL : *
Autoionition : * C

Autodecomposition : 270 C (518 F)

*Not available

Fire and Explosion Hazards:

OSHA Class III B Combustible Material. Will burn. Fire or high temp., above 270 C (518 F), and confined material will cause an explosion (see also Decomposition).

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Material Safety Data Sheet

(FIRE FIGHTING MEASURES - Continued)

Extinguishing Media

Water, Dry Chemical.

Carbon dioxide (CO2)

Fire Fighting Instructions

Evacuate personnel to a safe area. Flood with water. Cool tank/container with water spray.

Do not attempt to fight large or advanced fires; material will explode if confined and heated above 270 C. Fight smaller fires with unmanned or remotely activated equipment. Run-off from fire control may cause pollution.

ACCIDENTAL RELEASE MEASURES

Safeguards (Personnel)

NOTE: Review FIRE FIGHTING MEASURES and HANDLING (PERSONNEL) sections before proceeding with clean-up. Use appropriate PERSONAL PROTECTIVE EQUIPMENT during clean-up.

Accidental Release Measures

Evacuate area - admission should be limited to trained personnel wearing full protective equipment. If molten, dike, soak up with sand or other non-combustible absorbant and allow to freeze. Place solid material in a covered steel drum for disposal. Use non-sparking tools. Comply with Federal, State, and local regulations on reporting releases.

HANDLING AND STORAGE

Handling (Personnel)

Do not breathe vapor or mist. Do not breathe dust. Do not get on skin. Do not get on clothing. Do not get in eyes. Wash thoroughly after handling.

Use only with adequate ventilation.

Storage

Store in a well ventilated place.

Keep away from heat, sparks, and flame. Keep drums upright and tightly closed.

CEC00012

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Material Safety Data Sheet

EXPOSURE CONTROLS/PERSONAL PROTECTION

Engineering Controls

Use in a totally closed system. Ventilation should be provided to keep concentration below the exposure limits.

Personal Protective Equipment

Eye/Face

: Coverall chemical splash goggles.
Safety glasses (side shields);
full-length face shield.

Respirator

: Air supplied respirator. Suitable respiratory protection & chem. proof suit w/hood.

Additional

: Butyl rubber apron and footwear

Protective Gloves: Neoprene or butyl gauntlet- lined if handling hot material.

Exposure Guidelines

Exposure Limits

Dinitrotoluene Mixture

: 1.5 mg/m3, 8 Hr. TWA, Skin PEL (OSHA)

: 0.15 mg/m3, 8 Hr. TWA, A2, Skin TEV (ACGIH)

: None Established AEL * (Du Pont)

Other Applicable Exposure Limits

2.4-Dimitrotoluene

: 1.5 mg/m3, 8 Hr. TWA, Skin PEL (OSHA) : 1.5 mg/m3, 8.Hr. TWA. Skin TLV (ACGIH)

Notice of Intended Changes (1993-1994)

0.15 mg/m3, 8 Hr. TWA, AZ, Skin

: 0.15 mg/m3, 8 & 12 Hr. TWA, Skin AEL * (Du Pont)

<5% 2,6-DNT

2.6-Dinitrotoluene

: 1.5 mg/m3, 8 Hr. TWA, Skin PFI (OSHA)

: 0.15 mg/m3, 8 Hr. TWA, A2, Skin TLV (ACGIH)

AEL * (Du Pont) : None Established

* AEL is Du Pont's Acceptable Exposure Limit. Where oovernmentally imposed occupational exposure limits which are lower than the AEL are in effect, such limits shall take precedence.

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DuPont Material Safety Data Sheet

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PHYSICAL AND CHEMICAL PROPERTIES

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Physical Data

: _<1 mm/Hg @ 100 C (212 F) : 6.3 (Air = 1)

Vapor Pressure Vapor Density Evaporation Rate : _<1 0

: _<1 WT% Solubility in Water @ 22 C (72 F)

: Distinctive Nitro Aromat. Odor

: Solid/Molten Form : Medium Yellow Color : 1.32 @ 57C .. Specific Gravity

pH Information: Not available Appearance: Crystalline/Clear Oil

Boiling Point, 760 mmHg:Starts decomposing at 250 C (482 F)

Freezing Point: 56 C (133 F) dry basis

STABILITY AND REACTIVITY

Incompatil lity with Other Materials

Incompacible with strong oxidizers and caustics.

Polymerization

Polymerization will not occur.

Other Hazards

Instability: Unstable above 250 C (482 F). Will explode if confined and heated above 270 C (518 F).

Decomposition: May release hazardous Nitrogen Oxide (Nox) cases. Solid DNT is more sensitive to decomposition than liquid DNT. Contamination by foreign material, especially gritty substances, may considerably lower the decomposition temperature and increase the sensitivity of DNT to decomposition and explosion.

TOXICOLOGICAL INFORMATION

No Information Available

DuPont Material Safety Data Sheet Page 7

ECOLOGICAL INFORMATION

Ecotoxicological Information

Aquatic Toxicity

The product is moderately toxic (96-hr LC50 = 1 - 50 mg/l).

DISPOSAL CONSIDERATIONS

Waste Disposal

CEC00012

Comply with Federal, State, and local regulations. If approved, may be incinerated using special techniques. or removed to hazardous material landfill licensed for carcinogenic materials.

TRANSPORTATION INFORMATION

Shipping Information

DOT

Proper Shipping Name : Dinitrotoluene, Solid; Dinitrotoluene,

Molten

Hazard Class : ORM-E

I.D. No. (UN/NA) : Solid = 2038: Molten = 1600

DOT/IMO

Proper Shipping Name : Dinitrotoluenes, Solid; Dinitrotoluenes,

Molten

Hazard Class

UN No.

: Poison B, 6.1 : Solid = 2038; Molten = 1600

DOT/IMO Label

: Poison

DOT/IMO Label : Poison
Special Information : Flash Point: 173 C

Packing Group

: II

Reportable Quantity : 1000 lb

Shipping Containers

T/cars, T/trucks, steel drums

Shipping Information -- Canada . .

TDG

Proper Shipping Name : DINITROTOLUENE SOLID

PIN No.

: UN 2038

TDG Class

: 6.1 (9.2)

TDG Packing Group : II

CEC00012

DuPont

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Material Safety Data Sheet

REGULATORY INFORMATION

U.S. Federal Regulations

TSCA Inventory Status : Reported/Included.

Canadian Regulations

CLASS D Division 1 Subdivision B - Toxic Material/Acute Lethality.

CLASS D Division 2 Subdivision A - Very Toxic Material.

Carcinogen, Reproductive Toxin.

CLASS D Division 2 Subdivision B - Toxic Material. Skin or Eye Irritant, Skin Sensitizer.

OTHER INFORMATION

NEPA, NECA-HMIS

NPCA-HMIS Rating

Health

: 2

Flammability

: 1

Reactivity

: 1

Personal Protection rating to be supplied by user depending on use conditions.

Additional Information

For further information, see "Dinitrotoluene Mixture" Data Sheet.

Title III Classifications:

Acute Health - Yes Chronic Health - Yes Fire Hazard - No Reactivity - Yes Pressure - Yes

The data in this Material Safety Data Sheet relates only to the specific material designated herein and does not relate to use in combination with any other material or in any process.

Responsibility for MSDS : CHEMICALS & PIGMENTS Address : MISSISSAUGA, ONTARIO

Telephone : 416-821-3300

Indicates updated section.

End of MSDS

MSDS

Canadian Centre for Occupational Health and Safety

*** IDENTIFICATION ***

MSDS RECORD NUMBER : 691088

PRODUCT NAME(S)

: Sodium Nitrite Solution

PRODUCT IDENTIFICATION : MSDS NUMBER: CECO0191

DATE OF MSDS

: 1993-10-28

*** MANUFACTURER INFORMATION ***

HANUFACTURER

: DuPont Canada. Inc

ADDRESS

: Fost Office Box 2200

Streetsville

Mississauga Ontario Canada L5M 2H3

Telephone: 800-387-2122 (Product Information)

EMERGENCY TELEPHONE NO.: 613-348-3616 (Transport, 24 HOURS) 613-348-3616 (Medical, 24 HOURS)

*** SUPPLIER/DISTRIBUTOR INFORMATION ***

SUPPLIER/DISTRIBUTOR

: DuPont Canada, Inc

ADDRESS

: Post Office Box 2200

Streetsville

Mississauga Ontario Canada L5M 2H3

Telephone: 800-387-2122 (Product Information)

EMERGENCY TELEPHONE NO.: 613-348-3616 (Transport, 24 HOURS)

613-348-3616 (Medical, 24 HOURS)

*** MATERIAL SAFETY DATA ***

DuPont

Material Safety Data Sheet

Page 1

Sodium Nitrite Solution Revised 28-DCT-1993

Printed 3-FEB-1994

CHEMICAL PRODUCT/COMPANY IDENTIFICATION の 2010 まままま 101 min 1010 - 101 min 1010 min 10

Material Identification

Corporate MSDS Number : DU002807

Formula

: NaNO2 (in wåter)

CAS Name

: NITROUS ACID, SODIUM SALT

Grade

: TECHNICAL: OXIDIZING SALT SOLUTION

Company Identification

MANUFACTURER/DISTRIBUTOR

DuPont Canada, Inc.

P.O. BOX 2200 STREETSVILLE MISSISSAUGA, ONTARIO L5M 2H3

PHONE NUMBERS

Product Information : 1-800-387-2122

Transport Emergency : 1-613-348-3616 (24 HOURS)
Medical Emergency : 1-613-348-3616 (24 HOURS)

COMPOSITION/INFORMATION ON INGREDIENTS

Components

Material	UAS Number	7.
TECHNICAL GRADE: SUDIUM NITRITE WATER .	7632-00-0 7732-18-5	41 59
OXIDIZING SALT SOLUTION: SODIUM NITRITE SODIUM CARBONATE SODIUM NITRATE	7632-00-0 497-19-8 7631-99-4	40 2 10
WATER	7732-18-5	48

DSL: REPORTED/INCLUDED

HAZARDS IDENTIFICATION

Potential Health Effects

Harmful or fatal if swallowed. Harmful if inhaled. Overexposure by inhalation or ingestion may cause reduced oxygen carrying capacity of blood. Causes skin and eye irritation.

HUMAN HEALTH EFFECTS:

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DuPont

Material Safety Data Sheet

Page

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(HAZARDS IDENTIFICATION - Continued)

Human health effects of overexposure to the product by skin or eye contact may include skin irritation with discomfort or rash; or eye irritation with discomfort, tearing, or blurring of vision. Sodium nitrite has been infrequently associated with skin sensitization in humans. By inhalation, irritation of the upper respiratory passages with coughing may occur. By inhalation or ingestion, the effects may include low blood pressure with headache and fainting, or nonspecific discomfort such as nausea or weakness. Overexposure may also cause methemoglobinemia (reduced oxygen carrying capacity of the blood) with cyanosis (bluish discoloration of the skin), possibly progressing to dizziness, incoordination, shortness of breath, increased pulse rate, and loss of consciousness.

Sodium nitrite can also react with certain amines forming compounds which may cause cancer, mutations, or other toxicity. These compounds, known as nitrosamines, can be formed in acidic environments such as that found in the stomach. Since many medications and chemicals contain an amine group, simultaneous exposure to nitrites should be avoided.

Carcinogenicity Information

None of the components present in this material at concentrations equal to or greater than 0.1% are listed by IARC, NTP, OSHA or ACGIH as a carcinogen.

FIRST AIR MEASURES

First Aid

INHALATION

If inhaled, remove to fresh air. If not breathing give artificial respiration. If breathing is difficult, give oxygen. Call a physician.

SKIN CONTACT

In case of contact, immediately flush skin with plenty of water for at least 15 minutes while removing contaminated clothing. Call a physician. Wash clothing before reuse.

EYE CONTACT

In case of contact, immediately flush eyes with plenty of water for at least 15 minutes. Call a physician.

INGESTION

If swallowed, immediately give two glasses of water and induce vomiting. Call a physician. Never give anything by mouth to an unconscious person.

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(FIRST AID MEASURES - Continued)

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Material Safety Data Sheet

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Notes to Physicians

Absorption of this product into the body leads to the formation of methemoglobin which, in sufficient concentration, causes cyanosis. Since reversion of methemoglobin to hemoglobin occurs spontaneously after termination of exposure, moderate degrees of cyanosis need to be treated only by supportive measures such as bed rest and oxygen inhalation. Thorough cleansing of the entire contaminated area of the body including scalp and nails is of utmost importance. Cyanocobalamin (Vitamin B-12), 1 mg intramuscularly, will speed recovery. Intravenous fluids and blood transfusions may be indicated in very severe exposures.

Mark and the state of the state

Flammable Properties

Autodecomposition : 490 C (914 F) after drydown

Will not burn.

Fire and Explosion Hazards:

Strong oxidizer when water is removed. Combustible materials may catch fire more easily after being wet with sodium nitrite and dried. Product intensifies combustion of other materials. Fires are difficult to extinguish. See "Decomposition".

Extinguishing Media

As appropriate for combustibles in area.

Fire Fighting Instructions

Flood with water.

ACCIDENTAL RELEASE MEASURES

Safequards (Personnel)

NOTE: Review FIRE FIGHTING MEASURES and HANDLING (PERSONNEL) sections before proceeding with clean-up. Use appropriate PERSONAL PROTECTIVE EQUIPMENT during clean-up. Page DuPont CEC00191

Material Safety Data Sheet

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(ACCIDENTAL RELEASE MEASURES - Continued)

Accidental Release Measures

Flush spill area with plenty of water. Comply with Federal, State, and local regulations on reporting releases. Superfund reportable discharge for sodium nitrite is 100 lbs.

HANDLING AND STORAGE

Handling (Personnel)

Do not take internally. Keep from contact with clothing and other combustible materials. Avoid contact with eyes and skin. Avoid breathing vapors or mist. Avoid breathing dust from dried-down product. Wash thoroughly after handling.

Storage

Do not store with acids, ammonium salts, cyanides, amines or reducing agents.

EXPOSURE CONTROLS/PERSONAL PROTECTION

Engineering Controls

Good general ventilation should be provided to minimize contact with vapors, or dust from dried-down product.

Personal Protective Equipment

Eye/Face

: Coverall chemical splash goggles.

Protective Gloves

: Rubber aloves.

If product is allowed to dry and dusty conditions exist, use N)OSH/MSHA approved respiratory protection.

Exposure Guidelines

Applicable Exposure Limits

SODIUM NITRITE

PEL (OSHA)

(ACGIH) TLV

AEL * (Du Pont)

WEEL (AIHA)

: None Established

: None Established

: 2 mg/m3, 8 Hr. TWA, respirable dust

: None Established

SODIUM NITRITE

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DuPont Material Safety Data Sheet

Page

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(Continued)

PEL (OSHA)

(ACGIH) TLV

AFL * (Du Pont)

WEEL (AIHA)

: None Established : None Established

: 2 mg/m3, 8 Hr. TWA, respirable dust

: None Established

SODIUM CARBONATE

(OSHA) FEL.

(ACGIH) TIV

AEL * (Du Pont)

: None Established

; None Established

: 5 mg/m3, 8 Hr. TWA

* AEL is Du Pont's Acceptable Exposure Limit. Where governmentally imposed occupational exposure limits which are lower than the AEL are in effect, such limits shall take precedence.

PHYSICAL AND CHEMICAL PROPERTIES

Physical Data

Solubility in Water : 100 WT% Technical and Oxidizing Salt

Solution

Odor

: Odorless

Form

: Clear liquid

} !		! Oxidizino Salt! ! Solution !
!Color	Pale Yellow	! Straw Colored !
Epiling Pt., 760 mmHg	115 deg C (239 deg F)	! 114.5 deg C ! ! (238 deg F) !
!Freezing Point !		! ~10-20 deg C ! ! (50-68 deg F) !
!Specific Gravity	1.32 at 16 deg C (60 deg F)	!~1.4/16 deg C ! ! (34/60 deg F) !
!Vapor Pressure at ! 25 deg C ! 38 deg C	17 mmHg 35 mmHg	! ~50 mmHg ! ! ~90 mmHg !
!Vapor Density (Air=1)	Less than 1	! Less than 1
!pH Information	8.9	9
Evaporation Rate	Greater than 1	! Greater than 1!

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DuPont Material Safety Data Sheet Page

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STABILITY AND REACTIVITY

Chemical Stability

Unstable with heat after dry down.

Decomposition

Decomposes with heat.

Decomposition temperature is 490 deg C (914 deg F) after drydown to produce oxygen and toxic nitrogen gases.

Polymerization

Polymerization will not occur.

Other Hazards

Incompatibility : Incompatible with acids, ammonium salts, amines, activated carbon, cyanides, and

reducing agents. May react with secondary or tertiary amines to form nitrosamines (Certain nitrosamines are

cancer-suspect agents.).

TOXICOLOGICAL INFORMATION

U.S. Federal Regulations

TBCA Inventory Status : Reported/Included.

Canadian Regulations

CLASS C Oxidizing Material

CLASS D Division I Subdivision B - Toxic Material/Acute Lethality.

CLASS D Division 2 Subdivision B - Toxic Material. Skin or Eye Irritant.

CHECGOLDI

DuPont

Page 8

Material Safety Data Sheet

OTHER INFORMATION

Additional Information

Title III Classifications:

Acute Health - Yes Chronic Health - Yes Fire Hazard - No Reactivity - No Pressure - No

For further information, see Du Pont's "Sodium Nitrite" Data Sheet.

The data in this Material Safety Data Sheet relates only to the specific material designated herein and does not relate to use in combination with any other material or in any process.

Responsibility for MSDS : CHEMICALS & PIGMENTS Address : MISSISSAUGA, ONTARIO

Telephone : 416-821-3300

Indicates updated section.

End of MSDS

M S D S Canadian Centre for Occupational Health and Safety

*** IDENTIFICATION ***

MSDS RECORD NUMBER

: 756024

PRODUCT NAME(S)

: SODIUM NITRATE

PRODUCT IDENTIFICATION : 06SDNA

DATE OF MSDS

: 1994-06-09

*** MANUFACTURER INFORMATION ***

MANUFACTURER

: GRACE DEARBORN INC

ADDRESS

: 3451 ERINDALE STATION ROAD

MISSISSAUGA ONTARIO CANADA L5C 259

EMERGENCY TELEPHONE NO.: 905-279-2222 (OFFICE HOURS)

613-996-6666 (AFTER HOURS)

*** MATERIAL SAFETY DATA ***

Page 1

Version #:

MATERIAL SAFETY DATA SHEET: SODIUM NITRATE

1) PRODUCT IDENTIFICATION: SODIUM NITRATE

PRODUCT USE:

COMMODITY CHEMICAL

EMERGENCY PHONE:

MANUFACTURER:

GRACE DEARBORN INC.

3451 ERINDALE STATION ROAD

MISSISSAUGA, ONTARIO

OFFICE HOURS: 905-279-2222

AFTER HOURS: 613-996-6666

TRANSPORTATION OF DANGEROUS GOODS CLASSIFICATION:

SODIUM NITRATE 5.1 UN1478 III

WHMIS CLASSIFICATION:

CLASS C: CLASS D DIVISION 2 SUBDIVISION B

2) INGREDIENTS:

Chemical Name.

CAS #

TLV(mg/m3) LD50(mg/Kg

SODIUM NITRATE

7631-99-4

N/E

20000

%RANGE-(60.0- 100.0)

3) PHYSICAL DATA:

Physical state..... SOLID

Odour threshold..... N/D Specific gravity.... 1.28

Density..... N/D

pHannana 1% = 7 - 8

Solubility in water.. 73

Appearance and odour...

Freezing point.(Deg.C)N/A Boiling point..(Deg.C)N/A Vapour pressure.....N/A Vapour density(air=1).N/A Evaporation rate....N/A

Coeff. of water/oil...N/D

WHITE PELLETS, ODOURLESS 4) FIRE AND EXPLOSION HAZARD DATA: CONDITIONS OF FLAMMABILITY: NON-FLAMMABLE EXTINGUISHING MEDIA: WATER X FOAM X CO2 X Other : DRY CHEMICAL SPECIAL PROCEDURES: TREAT AS A CLASS A FIRE. MODERATE WHEN MIXED WITH ORGANIC MATTER - EXPLODES WHEN HEATED OVER 1000 DEGREES C - OXIDIZING AGENTS. FLASH POINT: (Deg. C PMCC) FLAMMABLE LIMITS IN AIR % BY VOLUME: LOWER N/D UPPER N/D AUTO IGNITION TEMP: (Dea. C) HAZARDOUS COMBUSTION PRODUCTS:N/D EXPLOSION DATA: SENSIFIVITY TO IMPACT.....: : MONE KNOWN SENSITIVITY TO STATIC DISCHARGES ..: NONE KNOWN Page 2 Version #: 3.00 MATERIAL SAFETY DATA SHEET: SODIUM NITRATE 5) REACTIVITY DATA: STABILITY (NORMAL COND.) STABLE X UNSTABLE CONDITIONS TO AVOID: AVOID EXTREME HEAT ABOVE 1000 DEGREES C CONDITIONS OF REACTIVITY: NZD INCOMPATIBILITY: (MATERIALS TO AVOID) ORGANIC MATERIALS HAZARDOUS DECOMPOSITION PRODUCTS: N/D 6) TOXICOLOGICAL PROPERTIES: ROUTE OF ENTRY: SKIN CONTACT X ABSORBED BY SKIN EYE CONTACT X INHALATION X INGESTION X EFFECTS OF ACUTE EXPOSURE MAY CAUSE IRRITATION TO SKIN AND EYES. AVOID PROLONGED AND/ OR REPEATED CONTACT. MAY CAUSE DISCOMFORT, NAUSEA OR VOMITING IF INGESTED. MAY CAUSE IRRITATION TO UPPER RESPIRATORY TRACT IF INHALED. EFFECTS OF CHRONIC EXPOSURE: NZD Oral rat LD50mg/Kg.(calc.):>2000 Exposure limits..... :N/D Sensitization.......N/D Synergistic Mat.....: :NONE KNOWN Carcinogenicity....: NONE KNOWN Reproductive Eff..... : NONE KNOWN Teratogenicity.....: NONE KNOWN Mutaginicity......: NONE KNOWN

7) PREVENTIVE MEASURES PERSONAL PROTECTIVE EQUIPMENT: CLOTHING: X GLOVES:X EYE PROTECTION: X RESPIRATORY PROTECTION: DUST MASK VENTILATION REQUIREMENTS: MECHANICAL (GENERAL) SPILL AND LEAK PROCEDURES: PICK UP DRY SPILLS AND RETURN TO CONTAINER. FLUSH REMAINDER TO DRAIN WITH EXCESS WATER. WASTE DISPOSAL: USE AN APPROVED SCAVENGER SERVICE. HANDLING PROCEDURES: WEAR CHEMICAL GOGGLES AND RUBBER GLOVES. USE PERSONAL PROTECTIVE CLOTKING: STORAGE REGUIREMENTS: STORE AWAY FROM ORGANICS IN DRY FIREPROOF BINS. WOOD AND PAPER BAGS SATURATED WITH SODIUM NITRATE SHOULD BE REMOVED FROM PREMISES. SPECIAL HANDLING INFORMATION: NONE 3.00 Version #: Page 3 SODIUM NITRATE MATERIAL SAFETY DATA SHEET: 8) FIRST AID MEASURES: WASH CONTAMINATED AREA THOROUGHLY WITH SOAP AND WATER. LAUNDER CLOTHING BEFORE REUSE. FLUSH EYES WITH FLOWING WATER FOR 15 MINUTES AND GET MEDICAL ATTENTION. IF INGESTED, INDUCE VOMITING AND GIVE LARGE QUANTITIES OF WATER AND GET MEDICAL ATTENTION IMMEDIATELY. GASTRIC LAVAGE MAY BE REQUIRED. 9) OTHER INFORMATION:

NONE

10) PREPARATION INFORMATION PREPARED BY: T.R.Erwin.

GRACE DEARBORN INC.

P.O. BOX 3060 STATION A.

MISSISSAUGA ONTARIO. L5A 3T5

DATE PREP./REV. 1994.06.01 PRINT DATE: 1994.06.09 PHONE: 905-279-2222 FAX: 905-279-0020

N/D-No Data N/A-Not Applicable N/E-Not Established <-Less >-Greater A=Oral rat LD50 B=Oral rat LD low C=oral LD50/LD low other animal D=Estimated 1000 E=Arbitrary 2000 F=Other Route Prefix C=Ceiling limit

SECTION 12.0.

SAMPLING PLAN

Project No.: UJ41014

Revision: 1

Date: 01/09/95

Project No.: UJ41014 Revision: 1 Date:01/09/95

12.0. SAMPLING PLAN

12.1. INTRODUCTION

This section describes the general process liquid and gas sampling procedures to be used including: the analytical parameters, typical locations and methods. The sampling and monitoring procedures described in this section have been selected to determine the properties and compositions of the feed stream, oxidized effluent stream and the off gases, thereby demonstrating the performance of the Wet Air Oxidation system.

12.2. SAMPLING EQUIPMENT, PROCEDURES AND LOCATIONS

The sampling equipment, procedures and locations are summarized in Table 12 -1. Figure 12-1 shows the incoming red water sampled at point 1; diluted red water sampled at point 2; oxidized effluent sampled at point 3 and offgases sampled at point 4. No sampling points were provided within the reactor system to minimize safety hazards associated with the cooling and pressure let down of hot samples.

12.3. ANALYTICAL PROCEDURES

The analyses planned for the samples are listed in Table 12 - 2.

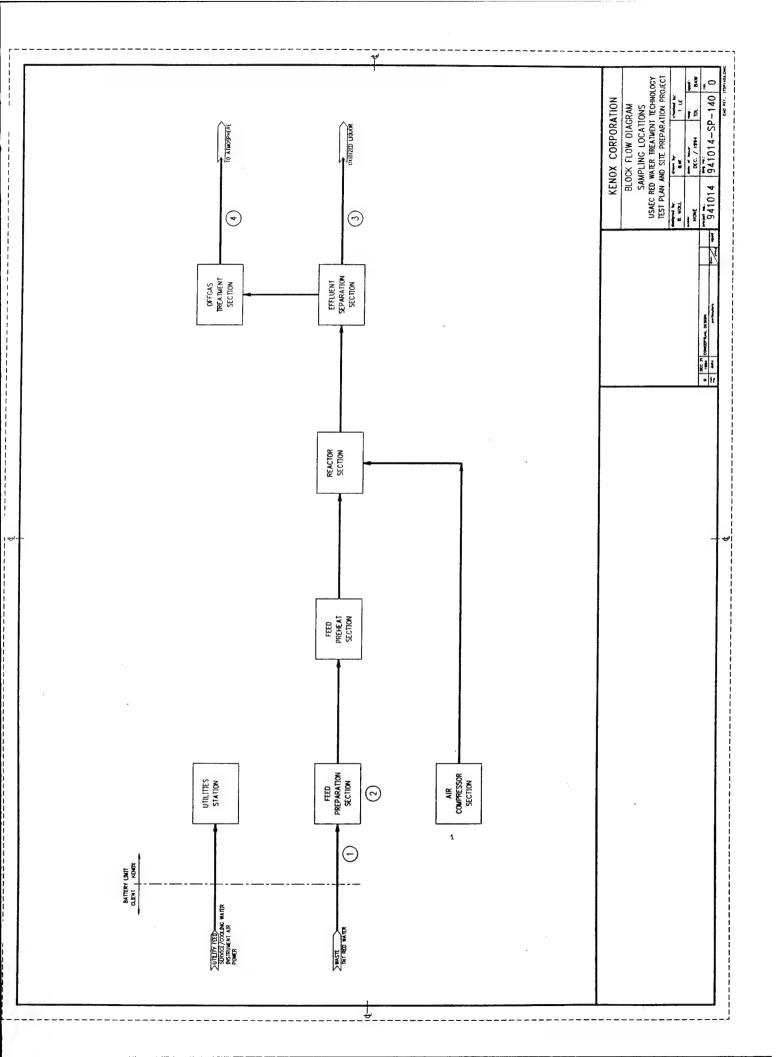
12.4. OPERATIONAL PARAMETERS

The operational parameters to be monitored by the DCS system include:

- pH of diluted red water to reactor system
- Level in feed drum
- Differential pressure across duplex strainer
- Flow of raw red water
- Flow of effluent recycle stream
- Flow of diluted red water to reactor system
- Temperature of feed at the tubeside outlet of the feed/effluent exchanger
- Temperature and pressure on the outlet line of the reactor system
- Temperature of oxidized effluent at the outlet of the feed/effluent exchanger
- Temperature of oxidized effluent at the outlet of the water cooler
- Level in high pressure separator
- Level in low pressure separator
- Pressure on vapour line of high pressure separator
- Pressure on vapour line of low pressure separator

Project No.: UJ41014 Revision: 1 Date: 01/09/95

- Temperature of oxidized waste water in effluent drum
- Level in effluent drum
- Air flows to the reactor system
- Air flow to the inlet of the feed/effluent exchanger
- Oxygen content in the offgas line
- Total offgas flow rate



Conceptual Design: Wet Air Oxidation Pilot Plant For Red Water Red Water Treatment Technology Test Plan & Site Preparation Project U.S. Army Environmental Center, Aberdeen Proving Ground, Maryland

Project No.: UJ41014 Revision : 1 Date :01/09/95

Table 12-1: Sample Collection Locations and Equipment

Fig. 12-1 Loc'n	Description	Access	Equipment	General Procedure
1	Raw Red	Tap	Glass	Hourly Grab
	Water		Bottle	Sample
2	Diluted Red	Tap	Glass	Hourly Grab
	Water		Bottle	Sample
3	Oxidized	Tap	Glass	Hourly Grab
	Effluent		Bottle	Sample
4	Offgases	Port	Bag Sample	Hourly Grab
				Sample

Table 12 - 2: Summary of Analytical Requirements and Methods

SAMPLE	ANALYSIS	METHOD
Raw Red Water/ Diluted Red Water/	рН	SM No. 4500-H ⁺
Oxidized Effluent	- 1000	CACAL FOOD HDH
	COD	SM No. 5220 "D"
	TOC	SM No. 5310 "B"
	Total Volatile Solids	SM No. 2540
	Total Solids	SM No. 2540
	Chlorides	ASTM D4327-91
	DNT sulfonates	Gas Chromatography
	alpha - TNT	Gas Chromatography
	2,4 DNT	Gas Chromatography
	2,6 DNT	Gas Chromatography
	1,3,5 TNB	Gas Chromatography
	1,3 DNB	Gas Chromatography
	Nitrite	SM No. 4500 - NO ₂
	Nitrate	SM No. 4500 - NO ₃
	Sulfate	ASTM D4327-91
Offgases	СО	Gas Chromatography
	CO ₂	Gas Chromatography
	NO	Infrared
	·	Spectrophotometry
	NO ₂	Electrochemical Sensor
	N ₂	Gas Chromatography
	NH ₃	Infrared
		Spectrophotometry
	02	Gas Chromatography
	· SO ₂	Infrared
		Spectrophotometry

[&]quot;ASTM" refers to <u>Annual Book of ASTM Standards</u>, Water and Environmental Technology, Section II, American Society for Testing and Materials.

[&]quot;SM" refers to Standard Methods for the Examination of Water and Wastewater, 18th Edition, 1992.

Project No.: UJ41014 Revision: 1 Date: 01/09/95

SECTION 13.0.

OPERATIONS MANUAL

13.0. OPERATIONS MANUAL

13.1. GENERAL DESCRIPTION

13.1.1 MANUAL PURPOSE

This manual provides instructions for the operations and maintenance of the red water WAO pilot plant.

13.1.2 SYSTEM DESCRIPTION

This section discusses the objectives, process equipment and process flow of the treatment system for red water. The pilot plant consists of the following processes:

- Kenox Wet Air Oxidation (WAO) system
- Utility systems.

KENOX WAO System

The operating flow rate of the WAO system which is comprised of red water and recycled effluent is 3 USGPM. Refer to Process Flow Diagram (PFD) in Section 3 for the following flow description.

Incoming TNT red water from the local storage tank is delivered to the Kenox feed drum D-104 via a dual strainer and the waste feed pump P-101. An excess differential pressure reading from local PDI-301 indicates the basket is plugged. The flow should be directed to the other basket and the plugged screen should be removed and replaced by a clean screen.

At the inlet of feed drum D-104, the TNT red water is blended with a treated effluent stream from the final effluent pump P-105 at a ratio that has been preset in the flow ratio controller, FFRC-401. The diluted feed is pumped from the feed drum by high pressure feed pump, P-103 to the tubeside of the feed/effluent exchanger E-101. In this exchanger, the feed stream temperature is heated to the required reactor inlet temperature by the reactors' effluents.

The Kenox reactor system comprises of reactors connected in series. Compressed air is injected into the reactors to supply the required oxygen for the reaction.

Project No.: UJ41014

Revision: 1

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The combined oxidized liquid and spent air is withdrawn from the reactors and cooled to 104 °F via E-101 and the water cooler E-103. Gases and oxidized waste water leave the cooler E-103 and proceed to a two stage pressure let down and separation system, D-101 and D-102.

The off-gas, which at this point is mainly carbon dioxide, nitrogen and water vapor is vented to the atmosphere. Part of the oxidized waste water is recycled back via the effluent recycle pump, P-105 to the inlet of the feed drum, D-104 and the other portion is discharged.

Compressed air is supplied to the Kenox reactors by the reciprocating compressor C-101. Compressed air leaving the compressor flows to the air accumulator D-103 before entering the Kenox reactors. The total air flow to the Kenox reactors is controlled by an oxygen analyzer which measures the O₂ content of the off gas leaving the system.

UTILITY SYSTEMS

Instrument air is assumed to be available on site.

Cooling water is assumed to be available on site. The cooling water supply/return system is shown in Dwg. No. 941014-FD-105.

13.1.3 KEY OPERATING PARAMETERS

The primary control for any Wet Air Oxidation system including "Kenox" is

- Feed Rate
- Oxygen Flow (Air Demand)
- Pressure in Reactors
- Reaction Temperature

Feed Rate

The feed to the Kenox System is limited by the size of the reactors and by the COD level to a lesser extent as there is a correlation between the flow rate and residence time.

Project No.: UJ41014 Revision: 1 Date: 01/09/95

Oxygen Flow

Excess oxygen is analyzed by AT-501 (Dwg. No. 941014-FD-104) located on the gas line releasing to the vent stack. Test runs will determine the optimum air supply requirements to the reactors.

Reactor Pressure

The pressure must be set so as to prevent boil-off and maintain a liquid phase in the reactors. The reaction enthalpy is used for heating up the liquid and oxygen containing gas feeds to the reaction temperature, evaporation of water up to the vapour-liquid equilibrium and compensation for heat losses from the reactors. This pressure is maintained by PCV-312 located on the vapor exit from separator D-101.

Reaction Temperature

The temperature is the most important process variable in the WAO process as it determines the rate of the oxidation reaction. The required temperature is determined by the chemical composition of the waste water and the desired conversion efficiency. For low COD heat must be added via the electric heater.

Project No.: UJ41014 Revision : 1 Date :01/09/95

13.2. START-UP PROCEDURE

13.2.1 START UP COOLING WATER SYSTEM

- Open valve on the 2" main cooling water line to the pilot plant.
- Open cooling water supply and cooling water return isolation valves to the following equipment:
 - 1. Air compressor, C-101
 - 2. Reactor Effluent Cooler, E-103
 - 3. Reactor System

13.2.2 ACTIVATE INSTRUMENT AIR SYSTEM

- Open all air supply valves to pneumatic instruments.
- Start up instrument air system. Check if pressure setting on valve PRV-XXX on the instrument air line is at 90 psig.

13.2.3 SYSTEM WATER FILL

- Activate process control system.
- Open suction and discharge valves around high pressure feed pump, P-103.
- Open all manual in-line process valves around the following equipment: E-101, E-102, reactor system, E-103, D-101, D-102 and inlet to D-105.
- Open service water supply isolation valves and XCV-602 by-pass valve to allow water flow to suction of P-103.
- Set reactor pressure controller, PIC-312 on the reactors to 590 psig.
- Start pump P-103. Adjust the variable speed drive to maintain a flow of 4 USGPM as indicated by FT-404.
- The following equipment will fill with water:
 - a) Tube side of exchanger E-101
 - b) Reactors
 - c) Shell side of exchanger E-101
 - d) Tube side of E-103
 - e) H.P. Separator, D-101

Project No.: UJ41014 Revision: 1 Date:01/09/95

- After D-101 fills to the 50 % level, open control valve, LCV-108, manually to allow water flow to L.P. Separator, D-102. Maintain 50 % level in D-101.
- Fill L.P. Separator, D-102 to the 50 % level and open LCV-110 manually to allow flow to D-105. Maintain 50 % level in D-102. Caution: do not overfill D-102. Oxygen analyzer AT-501 must not be in contact with water.
- Allow D-105 to fill to 50% level.
- Open discharge valve at the outlet of D-105, suction and discharge valves around effluent recycle pump, P-105 and valve to allow water to leave the system.
- Start pump, P-105.

13.2.4 INCREASE SYSTEM TEMPERATURE

- Adjust P-103 VSD to maintain a flow rate of 3 USGPM.
- Set temperature controller TIC-202 to 484 °F.
- Refer to electric heater, E-102, start-up procedure in the vendor's manual and start heater.
- Reactor system temperature, TI-209 should stabilize at 484 deg F.

13.2.5 PRESSURIZE SYSTEM

- Once the reactor temperature reaches 484 deg F, the system pressure, PI-312, will be approximately 590 psig.
- Open all manual in-line valves between the air compressor and the reactor system.
- Refer to compressor start-up procedure in vendor's manual.
- Start air compressor C-101.
- Oxygen analyzer controller AIC-501 should be set on override to allow full air flow into the reactor system.
- Set air flow controller FIC-407 at 232 lbs/hr and air flow ratio controller FFIC-408 to proportion the second air flow in the range of 50% of the total air flow. (FIC-407/408 to be operated manually).

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- Increase the pressure set point on pressure controller, PCV-312 in increments of 100 psig until the system stabilizes at 985 psig.
- Check system for leaks while raising pressure. It is expected that the reactor temperature will drop slightly when air is first admitted to the reactors.
- System stabilized at 985 psig check discharge pressure on the high pressure feed pump; pressure gauge PI-307 should read 1035 psig plus.
- Check all level instruments for appropriate settings.

13.2.6 INTRODUCTION OF WASTE WATER FEED STREAM

Once the reactor system stabilizes at 484 °F:

- Set the flow ratio control FFRC-401 such that flows of effluent recycle stream and feed waste meet the dilution factor.
- Open all manual valves on discharge of P-105 to allow recycle stream to flow to D-104.
- Start waste feed pump, P-101. Check PI-303 for discharge pressure. Reading should be approximately 30 psig.
- Observe FI-401 and FI-402, the flow ratio should agree with the dilution factor as set by FFRC-401.
- Allow D-104 to fill to 50 % level.
- Open manual discharge valve on D-104.
- Set oxygen analyzer, AT-501 at 5 % excess O2.
- Close all service water valves leading to the suction of P-103.
- Change air flow ratio controller FFIC-408 from manual to automatic mode (i.e. flow of air now on AIC-501 control).
- Optimize as necessary feed flow rate, FIC-407, FIC-408 and TI-209 to maintain temperature around 484 °F.
- Monitor reactor inlet temperature of waste water stream, TI-202 and reactor outlet temperature, TI 209.

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• Take a sample of the oxidized waste water periodically and have it analyzed for COD concentration and pH.

13.3. SHUTDOWN PROCEDURE

For a planned shutdown, waste water from the feed tank and partially oxidized waste water remaining in the system will be processed. After the processing of the waste, the system will be completely flushed so that all contaminated piping components are thoroughly cleaned and free of TNT red water.

The level of waste water in the feed drum will be decreased to the minimum operating level before commencing with the shutdown procedures. This will shorten the shutdown duration as well as save energy costs associated with operating the electric heater, E-102.

- Open service water isolation valve to waste water feed line no. 101. Close waste water feed valve to stop the flow of raw waste into drum D-104. This will allow service water to flush the incoming feed line.
- Adjust flow ratio controller FFIC-401 to allow 100 percent flow from P-101 and no flow of the effluent recycle stream.

This can be considered as time, T = 0 hr. (i.e. no contaminated liquid is being fed to D-104). Assuming the flow rate is 3 USGPM and D-104 is full, the approximate shutdown time is equal to 4 hours (i.e. 1.5 hours system liquid retention plus 2.5 hours D-104 volume).

As the feed from D-104 becomes increasingly dilute and the demand for COD decreases, the requirement for air will diminish and system temperatures will start to fall. As a result, air flow control valves FCV-407/8 will automatically close responding to the high oxygen level measured from the oxygen analyzer.

- Shutdown air compressor C-101 (refer to compressor operating manual). Control valves XCV-604/5 will close automatically cutting off the supply of air to the reactor system.
- Set temperature controller TIC-202 to 20 °C. Electric heater, E-102 will automatically return to 'Stand by' mode. All system temperatures will gradually fall.
- Decrease the set point of pressure controller PIC-312 in increments of 100 psi to slowly 'walk' the system pressure down.

At time T = 4 hours or later, adjust flow ratio controller FFIC-401 to allow rinse water discharged from P-105 to flush the effluent recycle line into D-104. After a few minutes reset FFIC-401 to 100 % flow from P-101.

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- Shutdown P-101.
- When the water in D-104 has reached the desired level shutdown P-103. The water remaining in D-104 can be used to dilute the next batch of raw waste.
- Shutdown P-105. The water left in the system can remain there until the next start-up. If maintenance is required, vent, drain and/or isolate as required.